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OPTIMIZATION OF CORRECTIVE SEQUENCES FOR INTERPLANETARY TERMINAL TRAJECTORIES

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GA/Phys/63-5,6

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FOR INTERPLANETARY TERMINAL TRAJECTORIES

THESIS

Presented to the Faculty of the School of Engineering of

the Air Force Institute of Technology

Air University

in Partial Fulfillment of the

Requirements for the Degree of

Master of Science

By

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Graduate Astronautical Engineering

August 1963

Preface

In this thesis, we analyzed the effect an error velocity has on the terminal hyperbolic transfer trajectory in the planet's local gravity field. Based on this analysis, the number, direction, magnitude and position of the correction impulses which optimally guide the space vehicle to a predetermined circular parking orbit was determined. Two approaches were used: (1) a fixed orbital radius; (2) an allowable variation of orbital radii over a specified range. Several techniques were used to make the study, but two deserve particular note. One technique used was a forced geometrical correction sequence developed by our advisor, Dr. C. A. Traenkle, and the second technique was dynamic programming which was developed by R. E. Bellman of the Rand Corporation. The results of this thesis bore out the general validity of Dr. Traenkle's approach.

We wish to acknowledge our indebtedness to our advisor, Dr. C. A. Traenkle, for the guidance he so willingly gave us. Working under him was a most rewarding experience. Special thanks are due our faculty advisor, Dr. W. L. Lehmann, for the suggested changes which improved the readability of our thesis. Finally, but by no means least, we thank our wives for the thankless task of typing our rough draft.

James E. Funk
George R. Hennig

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List of Symbols

a	semi-jajor axis
b	semi-minor axis
c	semi-focal distance
e	eccentricity
$\mathcal{E}$	total energy (per unit mass)
f	true anomoly
F	hyperbolic angle
$G=\mu$	gravitational constant for the planet
h	angular momentum
K	reduction number
ℓ	semi-latus rectum
m	magnification factor
n	number of corrections
ν	reduction factor
R	heliocentric referenced radius
n	local referenced radius
δr	radius incriment
t	time
V	velocity
ΔV	relative velocity or large velocity change
δV	error velocity or corrective impulse
ρ	miss distance per unit error velocity
ϕ	path angle between V and n where $\phi = 0$ is when the velocity vector is directed at the planet and positive rotation is clockwise
ω	angle of rotation of pericenter
θ	correction angle or error angle with respect to the velocity vector
ψ	correction angle or error angle with respect to the radius vector

Subscripts

1	with respect to the earth's orbit
2	with respect to the planet's orbit
c	circular
F	final position
ESC	escape
i	i^{th} number
IN	sphere of influence
∞	sphere of influence
INF	infinity
o	orbit
p	pericenter
PAR	parabolic
R	reference
S	planet's surface
Σ	sum
$\oplus$	Earth

Superscripts

R	reference
*	theoretical optimum
$\sim$	nonmalized

Abstract

The effect an error velocity has on the hyperbolic transfer trajectory in the planet's local gravity field is investigated. The number, direction, magnitude and position of the correction impulses which optimally guide the spacecraft to a circular parking orbit is determined. The two approaches used are: (1) a fixed and predetermined orbital radius; (2) an allowable variation of orbital radii over a specified range. Forced geometric and dynamic programming correction sequences analyses are used. The results prove a geometrical correction sequence to be optimum. The corrective velocity sum is always less than 5% of the basic velocity sum.

I. Introduction

Background

In the last few years, space travel and exploration have become very prominent in national effort. As the early space flights have shown, there is a great need for improved accuracy in space navigation. This problem is a difficult one on which much work is being done. This problem area may be subdivided into smaller study areas. In the realm of interplanetary space travel and exploration, three such subdivisions are the launch phase, mid-course phase and the terminal phase. In order for a mission to be successful, all three of these phases must be adequately completed. To study all three phases in one paper would be too large a topic for a thorough investigation. This thesis, therefore, will deal only with the latter topic, the terminal phase.

Statement of the Problem

The specific problem of this thesis is to determine the number, position, magnitude, and direction of the corrections to make to a terminal trajectory to reach the final circular orbital trajectory with a minimum expenditure of propulsive energy. The trajectory must start at the sphere of influence * and end on the circular orbit of predetermined

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* The sphere of influence is defined later in the chapter; however, it will suffice now to know that it defines the maximum range from the target planet at which the terminal phase of flight begins.

radius from the terminal planet. The change from the hyperbolic transfer trajectory to the circular orbital trajectory will always be made at pericenter of the hyperbolic transfer trajectory.

Methods of Approach to the Problem

Two different approaches to the problem will be taken in this thesis. In Part I, the correction sequence will always correct to a reference trajectory that will guide the spacecraft to a predetermined and fixed circular orbital trajectory. In Part II, the correction sequence will correct to a trajectory that will guide the spacecraft to a circular orbital trajectory whose radius may vary over a specified range. In Part I, two different analysis techniques are used, one of which was developed by Dr. C. A. Traenkle of the Aeronautical Research Laboratory at Wright-Patterson Air Force Base. The second technique, which is also used in Part II, is dynamic programming (introduced by R. E. Bellman of the Rand Corporation) which is a method of optimization by digital computer (Ref 1). Dynamic programming is a very sophisticated trial-and-error method of solution. This method has been applied to many different types of optimization problems and has been shown to give solutions where classical calculus of variations failed. Details of the method as it applies to this problem are given in the analysis in Part II.

Two supplementary analyses are made, one in each Part I and Part II. In Part I, a study is made on the position and velocity error at the sphere of influence due to an error velocity at injection. In Part II, a supplementary method of studying the effects of errors on trajectory parameters

is described; it is a study by linear peturbation analysis.

Variables Considered in the Error Analyses

In this thesis, the multi-variable problem is divided into a number of single variable problems, so that the individual effect of each variable on the total propulsive energy can be determined. The different variables investigated are listed below; however, they are not necessarily investigated in this order.

1. The radius of the final orbit
2. The angle between the initial velocity vector and the radius vector reversed (ϕ, path angle)
3. The magnitude of the initial velocity
4. Small deviations from the reference trajectory
5. Small deviations in the required corrective impulse
6. The number of corrections
7. The distance from the planet for a particular correction

Basic Assumptions

In order to solve the problem as outlined, three basic assumptions are made. Since the entire flight regime in which the space vehicle travels has extremely little atmospheric drag and since the target planet is the predominant source of the force field, the restricted two-body equations of motion are used. The second assumption, which is implied in the two-body equations of motion, is that the force field originates from a point source or that the density of the target planet is a function of the radius only. The third assumption is exact know-

ledge of the position vector and the velocity vector at any point on trajectory.

Sphere of Influence

In the solution of the restricted three-body problem, there are two collinear libration points lying on the axis joining the planet and the primary attraction body, which in these cases is the sun. These two points which lie approximately equidistant on either side of the planet define the diameter of the sphere of influence (Ref 4:7.5). This sphere, therefore, defines the outer boundary of the local gravity field. The gravity field at this boundary is not a central force field, but is directed normal to the collinear axis; however, it does converge quite rapidly to a central force field. This choice for the sphere of influence is admittedly arbitrary, but it still represents a reasonable selection.

Tolerance Criteria

Before the development and analysis is made on this thesis problem, a criteria must be established which will define tolerable increases to the basic velocity sum. Hopefully, the increase propellant requirement for corrective maneuvers should not exceed five percent of the basic velocity sum. The results of this study bore out all our expectations. In every case the increase requirement was less than five percent and, in many cases, much less.

PART I

II. Initial Conditions

The Two Orbital Radii

In this part of the thesis, the analysis will include two cases for each initial condition, namely the close orbital radius and the optimum orbital radius for the circular parking orbit. The close orbital radius is arbitrarily chosen as 1.1 times the planet's surface radius for the Venusian and Martian cases. This value should keep the space vehicle outside the sensible atmosphere. When the analysis is on the return trip to Earth, the close orbital radius is arbitrarily chosen as 6690 km which gives approximately a 300 km altitude. The optimum orbital radius is that radius at which the smallest velocity impulse is required to change the trajectory from a hyperbolic transfer to a circular orbital trajectory. It can be calculated from initial conditions; the mathematical development follows: In the following development, the subscript ∞ is for the sphere of influence and the subscript INF is for infinity. The kinetic energy for a hyperbolic trajectory in restricted two-body motion may be expressed as

$$V^2 = \frac{2\mu}{r} + \frac{\mu}{a} \qquad (1)$$

At the sphere of influence

$$E = \frac{V_\infty^2}{2} - \frac{\mu}{r_\infty} = \text{CONSTANT} \qquad (2)$$

$$V_{INF}^2 = 2E = \frac{\mu}{a} \qquad (3)$$

$$\frac{2\mu}{r} = V_{esc}^2 \text{ (at distance } r) \tag{4}$$

The energy equation may now be written as

$$V^2 = V_{esc}^2(r) + V_{INF}^2 \tag{5}$$

and at pericenter

$$V_p^2 = V_{esc}^2(r_p) + V_{INF}^2 \tag{6}$$

In order to go into a circular orbit at pericenter, a velocity impulse must be applied to slow the vehicle to a circular orbital velocity. Since

$$V_{co}^2 = \frac{\mu}{r_{co}} = \frac{\mu}{r_p} \tag{7}$$

$$\Delta V_p = V_p - V_{co} = \left[V_{esc}^2(r_p) + V_{INF}^2\right]^{1/2} - \frac{1}{\sqrt{2}} V_{esc}(r_p) \tag{8}$$

To find the minimum ΔV_p, the derivative of ΔV_p with respect to $V_{esc}(r_p)$ is set equal to zero. $V_{esc}(r_p)$ is the only variable since V_{INF} is fixed for any initial condition.

$$\frac{d\,\Delta V_p}{d\,V_{esc}(r_p)} = \frac{1}{2}\,\frac{2\,V_{esc}(r_p)}{\left[V_{esc}^2(r_p) + V_{INF}^2\right]^{1/2}} - \frac{1}{\sqrt{2}} = 0 \tag{9}$$

$$V_{esc}(r_p) = \frac{1}{\sqrt{2}}\left[V_{esc}^2(r_p) + V_{INF}^2\right]^{1/2} \tag{10}$$

$$V_{esc}^2(r_p) = \frac{1}{2}\left[V_{esc}^2(r_p) + V_{INF}^2\right] \tag{11}$$

$$V_{esc}^2(r_p) = V_{INF}^2 \tag{12}$$

$$V_{esc}(r_p) = V_{INF} \tag{13}$$

Now substitute $V_{esc}(r_p) = V_{INF}$ into the equation for ΔV_p

$$\Delta V_p = \left[V_{INF}^2 + V_{INF}^2\right]^{1/2} - \frac{1}{\sqrt{2}} V_{INF} = \frac{1}{\sqrt{2}} V_{INF} \tag{14}$$

The hyperbolic velocity at pericenter is equal to $\sqrt{2}\, V_{INF}$ which when substituted into the energy equation defines the orbital radius (Ref 2:7)

$$2V_{INF}^2 = \frac{2\mu}{r_p^*} + V_{INF}^2 \tag{15}$$

or

$$r_p^* = \frac{2\mu}{V_{INF}^2} \tag{16}$$

<u>Initial Conditions to be Studied</u>

In order to ease a correlation of the results of this thesis with the results of studies on general intersecting reflection trajectories, the initial conditions chosen will be of several class types of reflection trajectories for Venus and Mars. Four types of reflection trajectories will be chosen for each of the two planets. Each of these four types will be analyzed for both the optimal and close orbital trajectories at both the planets (Venus and Mars) and Earth. The particular ones chosen are those as defined in reference 2. For the planet Venus, the four trajectory types are: (1) Hohmann, (2) class A, (3) class C, (4) class D. For Mars the trajectory types are: (1) Hohmann, (2) class A (3) class B, (4) class C. The Hohmann transfer trajectory is

classic and is the minimum energy transfer where the orbit is tangent to both the earth's orbit and the target planet's orbit. A class A trajectory has the same energy content as the Hohmann, but the trajectory is nowhere tangent to either orbits R_1 or R_2 . A class B trajectory has an semi-major axis equal to R_2 . A class C trajectory is tangent to only orbit R_1 and a class D trajectory is tangent to only orbit R_2 . In Appendix A, the trajectory classes are designated in the code Class EX---0.0---A or Class IN---0.0---C. The last letter is the class designation and the other items further classify the trajectories. The further classification is of no significance to the analysis of this thesis and the reader may read Ref 2 for further clarification of this terminology. It was included in order to simplify any cross check of the input data. Tables 1 and 2 (Ref 3:table 3) below list the input data in which the velocities were normalized with respect to the earth's orbital velocity (29.8 km/sec) and the distances were normalized with respect to the target planet's mean radius. The constants for the earth are:

$$r_s = 6370\ km, \quad \tilde{r}_\infty = 235, \quad \mu = 399000\ km^3/sec^2$$

The $\Delta\tilde{V}_1$ listed in these two tables are the values of the relative velocity of the spacecraft with respect to the Earth for each transfer trajectory type. The $\Delta\tilde{V}_2$ are the relative velocities of the spacecraft with respect to the target planet. The sum of $\Delta\tilde{V}_1$ and $\Delta\tilde{V}_2$, which is the basic velocity correction sum, $\tilde{V}_\Sigma$, is the amount required to change from the Earth's orbit to the transfer trajectory and to change from the transfer trajectory to the target planet's orbit (or vice versa). This velocity sum,

however, neglects the energy required to escape from the local gravity field. Therefore, any percentage comparison of the corrective velocity maneuvers to this basic velocity sum will be a conservative figure.

Table I

Initial Conditions for Venusian Trajectories

$r_s = 6179$ km, $\tilde{r}_\infty = 163.5$, $\mu = 325000$ km³/sec

Class	$\Delta\tilde{V}_1$	$\Delta\tilde{V}_2$	$\tilde{V}_\Sigma$
H	0.085	0.093	0.178
A	0.191	0.237	0.428
C	0.208	0.443	0.651
D	0.218	0.127	0.345

Table II

Initial Conditions for Martian Trajectories

$r_s = 3376$ km, $\tilde{r}_\infty = 321.1$, $\mu = 43100$ km³/sec²

Class	$\Delta\tilde{V}_1$	$\Delta\tilde{V}_2$	$\tilde{V}_\Sigma$
H	0.099	0.089	0.188
A	0.305	0.229	0.534
B	0.301	0.338	0.639
C	0.355	0.605	0.960

III. Equations of Motion and Error Analysis

Change from Absolute to Relative Motion

To calculate the initial conditions used in this thesis, the relative motion of the spacecraft with respect to the target planet must be determined. Fig. I shows a general intersecting transfer trajectory where the planets and the sun are assumed point masses. If one assumed that the planet's mass were non existant, the intersection between the transfer trajectory and the target planet's orbit would represent the collision of the space vehicle and the planet. The velocity of these two bodies is easily calculated. In turn, the relative motion between these two bodies is also easily derived. Since the sphere of influence is quite small in Heliocentric space, the velocity vectors of the spacecraft and the planet vary very little at the point the spacecraft enters the sphere of influence from the hypothetical intersection of the two trajectories. Therefore, with very little error, the relative velocity of the spacecraft with respect to the target planet is known at the point the spacecraft enters the

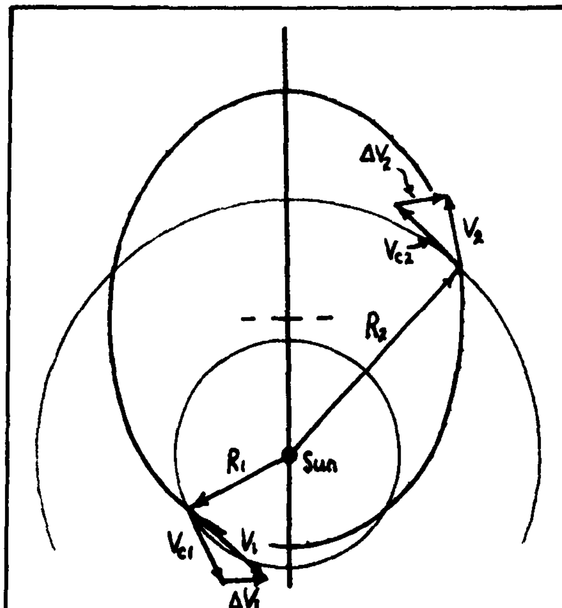


Fig. I
GENERAL TRANSFER TRAJECTORY

sphere of influence. What is not immediately obvious, however, is the importance of where the space vehicle enters the sphere of influence. Fig. 2 shows the space vehicle entering the sphere of influence at two different points which are very close in Heliocentric space. If the spacecraft enters at point A, very little or possibly no corrective impulse would be required for a successful terminal trajectory. If the spacecraft enters at point B, however, the relative motion is such that the spacecraft is traveling away from the target planet before interception even occurred. Only by a large corrective impulse could the space vehicle be directed towards the planet. In any case where $90° < \phi_\infty < 270°$, the penetration of the sphere of influence would be momentary; therefore, the closest point of approach to the planet would be equal to the radius of the sphere of influence. For all practical purposes, such an interception would be a complete miss. The

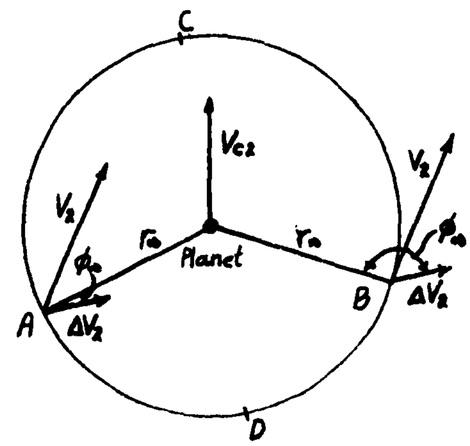


FIG. 2

SPHERE OF INFLUENCE INTERCEPT

analysis of the corrective maneuver will be limited to cases where

$$-90^\circ \leq \phi_\infty \leq +90^\circ \quad .$$

Reference Trajectory Parameters

For any given velocity magnitude, there is only one hyperbolic transfer trajectory that will guide the space vehicle to a desired pericenter distance, which has already been chosen since the pericenter distance must equal the circular parking orbital radius. Since there are two different desired orbital radii (close and optimal), the development of the trajectory parameters will be general and referred to as the reference parameters. The close and optimal cases will be special cases of the reference trajectory.

Since the velocity at the sphere of influence is known, the energy of the hyperbolic trajectory can be calculated from the equation

$$E^R = \frac{V_\infty^2}{2} - \frac{\mu}{r_\infty} = \text{CONSTANT} \tag{17}$$

At infinity, r is infinite and

$$V_{INF}^2 = 2E^R \tag{18}$$

Therefore, the optimal orbital radius is equal to

$$r^* = \frac{2\mu}{V_{INF}^2} \tag{19}$$

To repeat, the close orbital radius is either $1.1 \times r_s$ for Venus and Mars or 6690 km for Earth. Since the energy is constant, a is also constant

$$\frac{\mu}{a} = V_{INF}^2 = 2E^R \tag{20}$$

$$a^R = \frac{\mu}{2E^R} \tag{21}$$

Now, for a hyperbolic trajectory

$$r_p = a(e-1) \tag{22}$$

therefore,

$$e^R = \frac{r_p^R}{a^R} + 1 \tag{23}$$

Also

$$(b^R)^2 = (c^R)^2 - (a^R)^2 \tag{24}$$

$$b^R = a^R\left[(e^R)^2 - 1\right] \tag{25}$$

Now at pericenter, the $\sin\phi = 1$, and

$$V_p^2 = \left[\mu\left(\frac{2}{r_p^R} + \frac{1}{a^R}\right)\right]^{1/2} \tag{26}$$

Since

$$h = r \times V \times \sin\phi \tag{27}$$

$$h^R = r_p^R \times V_p^R \tag{28}$$

Now the circular orbital velocity is

$$(V_{co}^R)^2 = \frac{\mu}{r_p^R} \tag{29}$$

and the velocity impulse needed to change from a hyperbolic trajectory to the circular parking orbit is

$$\Delta V_p^R = V_p^R - V_{co}^R \tag{30}$$

Therefore, if the magnitude of the velocity at the sphere of influence and the circular orbital radius is known all the reference trajectory parameters are easily calculated. Also, the reference velocity and the

associated angle ϕ at any distance r can be calculated by

$$V^R(r) = \left[\mu\left(\frac{2}{r} + \frac{1}{a^R}\right)\right]^{1/2} \tag{31}$$

$$\phi^R(r) = \arcsin \frac{h^R}{r V^R(r)} \tag{32}$$

With these equations, any parameter of the reference trajectory at any distance r from the planet can easily be calculated and it will be assumed that this knowledge is known for the two trajectory types (close and optimal) from hence on.

Rotating Co-ordinate System

Since the object of the terminal maneuvers is to direct the spacecraft into a circular parking orbit by an applied velocity impulse at pericenter of the hyperbolic transfer trajectory, the angular position of pericenter is unimportant. The only requirement, therefore, is to guide the space vehicle to the pericenter distance which equals the parking orbital radius. If the spacecraft followed the reference hyperbolic trajectory all the way in, it would be at the proper distance when it arrived at pericenter. If, however, the space vehicle deviated from this reference trajectory, it would no longer arrive at the predesignated pericenter distance. At some point on the inbound leg, then, a corrective velocity impulse must be applied to properly guide the spacecraft to the desired pericenter distance. The absolute location of this pericenter, however, would rotate through and angle ω (see Fig. 3). The absolute location of pericenter is of no consequence and,

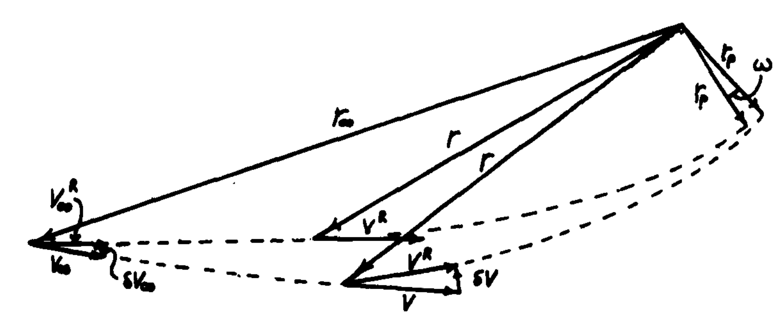


FIG. 3

INBOUND ERROR ANALYSIS

since pericenter is at the desired distance from the planet, the terminal maneuver would be completely successful. In the analysis to follow, the corrective maneuvers will always be to redirect the velocity vector to the reference velocity vector.

Effect of Error Velocity

If the velocity is in error with respect to the reference velocity, the error may be expressed as some δV from the reference velocity (Fig. 4). This error velocity may also be written as components longitudinal and transverse with respect to the reference velocity. The two limiting cases, therefore, would be when the error velocity is all longitudinal or all transverse. The effect of the longitudinal and cross (transverse) error velocities will now be investigated.

The error velocity must be vectorally added to the reference velocity in order to determine the actual velocity vector. For the longitudinal case, V and ϕ are

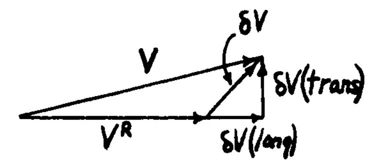


Fig. 4
Error Velocity

$$V = V^R + \delta V \tag{33}$$

$$\phi = \phi^R \tag{34}$$

For the transverse case, V and ϕ are

$$V = \left[(V^R)^2 + (\delta V)^2\right]^{1/2} \tag{35}$$

$$\phi = \phi^R + \arctan \frac{\delta V}{V^R} \tag{36}$$

With these two sets of equations, the resultant velocity can always be calculated at any r, since the reference values are known for any r. Since the velocity vector and ϕ at some r are no longer the reference values, the trajectory parameters have also changed. Re-writing the energy equation, a new a can be computed

$$V^2 = \mu\left(\frac{2}{r} + \frac{1}{a}\right) \tag{37}$$

$$a = \frac{\mu r}{rV^2 - 2\mu} \tag{38}$$

Continuing the computation

$$h = r \times V \times \sin\phi \tag{39}$$

$$E = \frac{\mu}{2a} \tag{40}$$

Since

$$b^2 = a^2(e^2-1) = a\frac{h^2}{\mu} = \frac{h^2}{2E} \tag{41}$$

$$b = \left[\frac{h^2}{2E}\right]^{1/2} \tag{42}$$

and

$$e = \left[\frac{b^2}{a^2} + 1\right]^{1/2} \tag{43}$$

$$r_p = a(e-1) \tag{44}$$

Now the radial deviation of the pericenter distance with respect to the reference trajectories pericenter distance is

$$\delta r_p = r_p - r_p^R \tag{45}$$

Only the magnitude of the difference of the radial pericenter distances is important, since the mission's end result is to orbit the planet at the chosen radius.

Magnitude of Error Velocity

To analyze the magnitude of the pericenter miss distance some maximum value of error velocity must be chosen. This value must liberally exceed the tolerance capability of rocket systems yet must not be too large to produce non-linear results. A maximum error velocity of two one-thousandths of the earth's orbital velocity should be very suitable

(Ref 5:7). Statistically, the root-mean-square of the maximum is the best choice for an average error. The average error velocity used in the following analysis, therefore, is

$$\delta\tilde{V} = 0.00141 \tag{46}$$

$$\delta V \approx 42 \ ^{m}/_{sec} \tag{47}$$

Sphere of Influence Entry Error Analysis

When the reference trajectory parameters were derived, only the magnitude of the relative velocity was used in the computation. It was assumed (though not explicitly stated) that the velocity vector had the required direction. If the direction of rotation about the target planet is immaterial, there are only two points the spacecraft may enter the sphere of influence (in two-dimensional motion). In this analysis, however, counter-clockwise rotation will be required and only the one where ϕ_∞ is positive is acceptable (positive ϕ is clockwise).

At the sphere of influence, the angle ϕ is very nearly equal to

$$\phi_\infty^R = \arctan \frac{b^R}{r_\infty} \tag{48}$$

Since r_∞ is a constant for any particular planet, the value of b may represent the collision parameter where b^R would be the required value. As ϕ_∞ is restricted to lie between -90° and 90° for a useful intercept of the sphere of influence, only this range will be investigated.

Since r_∞ and V_∞^R are known

$$h = r_\infty \times V_\infty^R \times \sin\phi_\infty \tag{49}$$

$$E = \frac{(V_\infty^R)^2}{2} - \frac{\mu}{r_\infty} \tag{50}$$

$$b = \frac{h^2}{2E} \tag{51}$$

The ratio $\frac{b}{b^R}$ indicates the magnitude by which the collision parameter was missed. The velocity correction needed to redirect the velocity vector in the required direction may be calculated by

$$\delta V_\infty = \sqrt{2}\, V_\infty^R \left[1 - \cos \delta\phi_\infty\right]^{1/2} \text{ where } \delta\phi_\infty = \phi_\infty^R - \phi_\infty \tag{52}$$

For this analysis, only eight solutions were calculated where ϕ varied from -90° to $+90^\circ$ in 10° incriments. The eight cases were:

Venus---Hohmann, OPT---class A, OPT---class C, Close---class D, OPT

Mars----Hohmann, OPT---class A, Close-class B, Close---class C, Close

Longitudinal and Transverse Error Velocity Analysis

To compare the effects of the longitudinal and transverse error velocities, twenty-eight test solutions were run. The δr_p was calculated for each case at five range incriments,

$$r_i = r_p^R + i \times \frac{r_\infty - r_p^R}{5} \quad \text{where } i = 1,2,3,4,5 \tag{53}$$

for both the longitudinal and cross velocity errors. The results in each case lead to the same conclusion: the transverse error velocity caused much larger miss distances than the same magnitude longitudinal error velocity. In 19 out of the 28 cases for $r_i = r_\infty$ the cross error velocity caused over 100 times the miss distance than the longitudinal error velocity. At this same range, the closest that the ratio came to unity was for the Venus trajectory--class H-OPT--where the transverse error

effect was only 18.5 times as great. At the range closest to pericenter distance, r_1 , in 18 out of the 28 cases the cross error velocity caused over 25 times the miss distance than the longitudinal error. Again, the Venus trajectory --class H-OPT-- resulted in the closest ratio. This time, the transverse error velocity caused about 7 times the miss distance than the longitudinal velocity error. The data in Appendix A contains the results for all 28 cases. Since the optimum orbital radius for Venus class C and Mars classes A, B, and C were less than the respective planet's radius, only the close orbital radius trajectories were investigated. (This exclusion is true throughout the thesis).

Error Analysis Assumptions

To transform the δr_p to a miss distance per unit error velocity, δr_p is divided by the error velocity, δV. This new value is termed ρ . To think in reverse, ρ could also be the value a unit corrective impulse would change the pericenter distance. Since a transverse error velocity had such a predominant effect on pericenter distance compared to the longitudinal error, the ρ for the transverse case will be equally predominant over the ρ for the longitudinal case. Therefore, any corrective velocity impulse would be most effectively applied transverse to the desired reference velocity. From here on, all corrective impulses will be applied transversely to the reference velocity vector.

A very basic change in thinking must now take place. Up to this point in the analysis, an error velocity was applied to the reference velocity and the resulting miss distance was calculated. Now, for any

given miss distance which resulted from some error velocity, a corrective impulse may be applied at any r to correct for this miss distance. Therefore, ρ not only represents the effect of a unit error velocity on pericenter distance but also represents the effect of a unit corrective impulse on pericenter distance.

In order to distinguish between error velocities and corrective velocity impulses, from here on the error velocity will be designated with an E superscript, δV^E. The corrective impulse will be without any superscript. Also, the error velocity will always be a constant value no matter where it occurs in the trajectory.

Constant Magnitude Corrective Impulse Error Analysis*

First of all, three new terms which will be used in the error analysis must be defined. The reduction factor, Q, is defined by the equation

$$Q_i = \frac{\rho_i}{\rho_\infty} \quad \text{where } i \text{ specifies the } i^{th} \text{ range position} \tag{54}$$

The reduction factor, therefore, indicates the reduced effect a unit error velocity has on the pericenter distance as the range decreases. The reduction number, K, is the fractional amount that the reduction factor is reduced between any two correction positions. The third term is the magnification number, m, which is just the inverse of K

$$m = \frac{1}{K} \tag{55}$$

* This analysis was taken from a lecture series presented by Dr. C. A. Traenkle in April 1963 at the Air Force Institute of Technology, Wright-Patterson AFB, Ohio.

Of particular interest in this analysis will be the final values (at the last correction position before pericenter) of Q and m which will be designated by the subscript F.

For a given error velocity at the sphere of influence the pericenter miss distance is

$$\delta r_p(\infty) = \rho_\infty \, \delta V^E \tag{56}$$

At some range closer to the planet, a corrective impulse is made to correct for the error

$$\delta V_1 = \frac{\delta r_p(\infty)}{\rho_1} = \frac{1}{K}\,\delta V^E \tag{57}$$

However, the correction velocity δV_1 is not completely accurate and may be in error by δV^E. The new miss distance is

$$\delta r_p(1) = \rho_1 \, \delta V^E \tag{58}$$

To have a constant magnitude corrective impulse, the next correction velocity must equal

$$\delta V_2 = \delta V_1 \tag{59}$$

$$\delta V_2 = \frac{\delta r_p(1)}{\rho_2} = \frac{\rho_1}{\rho_2}\,\delta V^E = \frac{1}{K}\,\delta V^E \tag{60}$$

and K, therefore, must be a constant. Again the miss distance has been reduced and equals

$$\delta r_p(2) = \rho_2 \, \delta V^E \tag{61}$$

The total reduction in the miss distance from the original error at the sphere of influence is

$$\frac{\delta r_p(2)}{\delta r_p(\infty)} = Q_2 = \frac{\rho_2}{\rho_\infty} = \frac{\rho_2}{\rho_1}\cdot\frac{\rho_1}{\rho_\infty} = K^2 \tag{62}$$

If this sequence is continued up to n corrections, each

$$\delta V_i = \frac{1}{K}\,\delta V^{\epsilon} \tag{63}$$

The sum of the squares of the δV_i is

$$\delta V_{\Sigma}^{2} = n\,\frac{1}{K^2}\left[\delta V^{\epsilon}\right]^2 \tag{64}$$

or

$$\frac{\delta V_{\Sigma}}{\delta V^{\epsilon}} = n^{1/2}\,\frac{1}{K} \tag{65}$$

As a result of the n corrections, the final miss distance had been reduced to

$$Q_F = \frac{\delta r_p(n)}{\delta r_p(\infty)} = \frac{\rho_n}{\rho_\infty} = \frac{\rho_n}{\rho_{n-1}}\cdot\frac{\rho_{n-1}}{\rho_{n-2}}\cdots\frac{\rho_2}{\rho_1}\,\frac{\rho_1}{\rho_\infty} = K^n \tag{66}$$

or

$$K = Q_F^{1/n} \tag{67}$$

The sum $\frac{\delta V_{\Sigma}}{\delta V^{\epsilon}}$, therefore, is

$$\frac{\delta V_{\Sigma}}{\delta V^{\epsilon}} = n^{1/2}\,\frac{1}{K} = n^{1/2}\,\frac{1}{Q_F^{1/n}} = n^{1/2}\,m_F^{1/n} \tag{68}$$

For any given tolerance on the pericenter miss distance, Q_F and m_F are known values and a minimum $\frac{\delta V_{\Sigma}}{\delta V^{\epsilon}}$ can be found. For a ten percent tolerance in altitude

$$Q_F = \frac{\delta r_p(F)}{\delta r_p(\infty)} = \frac{\tilde{r}_p^{R}-1}{10\,\delta r_p(\infty)} \tag{69}$$

To find the minimum velocity sum, first take the natural logarithm of both sides; then take the derivitive with respect to n and set it equal to zero.

$$\ln\left[\frac{\delta V_{\Sigma}}{\delta V^{\epsilon}}\right] = \frac{1}{2}\ln(n) + \frac{1}{n}\ln(m_F) \tag{70}$$

$$\frac{d}{dn}\ln\left[\frac{\delta V_{\Sigma}}{\delta V^{\epsilon}}\right] = \frac{1}{2n} - \frac{1}{n^2}\ln(m_F) = 0 \tag{71}$$

$$n = 2\ln(m_F) \tag{72}$$

To check for a minimum

$$\frac{d^2}{dn^2}\ln\left[\frac{\delta V_T}{\delta V}\right] = \frac{-1}{2n^2} + \frac{2}{n^3}\ln(m_F) \tag{73}$$

Substitute (72) into (73)

$$\frac{d^2}{dn^2}\ln\left[\frac{\delta V_T}{\delta V}\right] = \frac{-1}{8\ln^2 m_F} + \frac{1}{4\ln^2 m_F} > 0 \tag{74}$$

Therefore, n gives the minimum value and is the optimum number of corrections.

$$n^* = 2\ln(m_F) \tag{75}$$

Variable Magnitude Corrective Impulse Error Analysis

In the previous error analysis, the fact that K remained a constant predetermined the magnitude of δV_i for any given n. If K were to vary, there would be no way to know what the magnitude of the corrective impulses would be by just knowing n. In this analysis, K will be allowed to vary as well as the number of corrections. A very simple form of Dynamic Programming will be employed in this digital computer analysis (see program 3 for the complete program).

Again, by prescribing a miss distance tolerance, Q_F is known and with this value, the range to the last correction position can be read from a graph of Q vs range (see Fig 16 for an example plot). The distance between this final range and the sphere of influence is divided equally into 500 range positions

$$r_i = r_F + i \times \frac{r_s - r_F}{500} \quad \text{where } i = 1, 2, 3, \cdots 500 \tag{76}$$

Now for each of these range positions ρ_i is calculated and stored in the computer memory. Since ρ_i is now known, the square of δV_i at any r_i due to an error at r_∞ is calculated and stored in the computer memory (DDV(J) in the program).

If only one correction is made, it must be done at r_f if the tolerance is to be met. If two or more corrections are made, the last correction must be made at r_f , but all the others may be optimized over the range of correction position. In this analysis, the maximum number of corrections is 15. The computer program will find the optimum number of corrections between 1 and 15 and the ranges at which the corrections are made.

Fig. 5 (next page) is the flow diagram for the optimization portion of the computer program. The values of ρ_i and DDV(J) were calculated and stored prior to entering this portion of the program. The portion of the program which follows what is in Fig. 5 is the computations of the time intervals from each correction position to pericenter for the optimum case only. This analysis is the optimization of the root mean square of the velocity corrections. Since the computer time required for each initial condition was approximately nine minutes, only six solutions were run. These were:

Mars-Hohmann	(1) optimum (2) close
Venus-class A	(3) optimum (4) close
Mars-Return-class A	(5) optimum (6) close

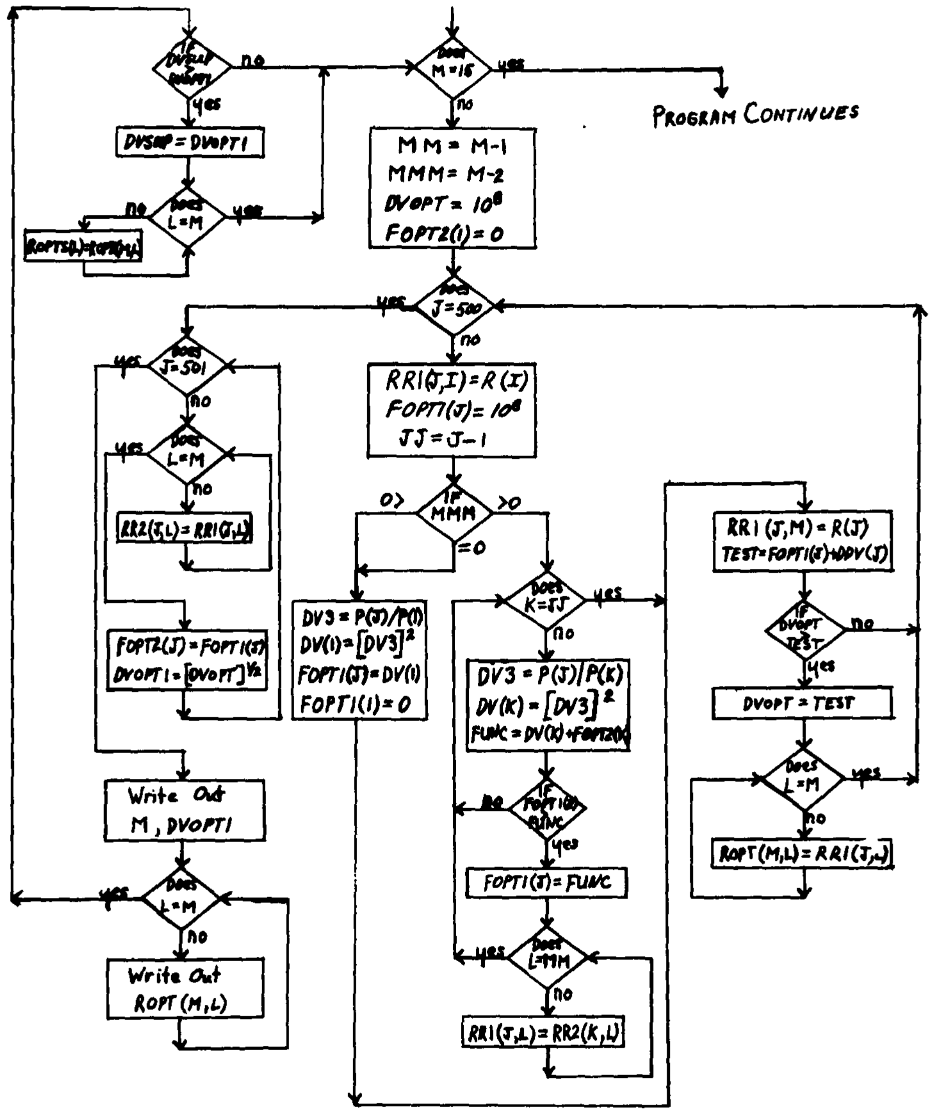


Fig. 5

Multi-Step Variable Reduction Number Program

Time to Pericenter

Since a finite time period will be necessary to make position measurements, some check must be made on the time interval between correction positions. Since all the trajectory parameters are known, the Keplerian time equation is readily solved. If r is known the

$$\cosh F = \frac{1}{e}\left(1+\frac{r}{a}\right) \tag{77}$$

from which F and $\sinh F$ can be solved. The time to pericenter, then, is

$$t = \frac{T}{2\pi}\left[e \sinh F - F\right] \quad where \quad T = 2\pi \frac{a^{3/2}}{\mu^{1/2}} \tag{78}$$

Once the times to pericenter are known for each correction position, the time between positions is easily calculated. Since r was not explicitly determined in the solutions for the constant magnitude corrective impulses, these values must be taken from the Q vs range plots. As will be noted later in the discussion and results, the Q vs range plots were very nearly straight line functions with a slope equal to $\frac{1}{r_\infty - r_p}$. As all the solutions were calculated on a digital computer, this simplifying assumption was used in the calculation of r for the time equations for the constant magnitude corrective impulse analysis.

$$r_i = r_p + (r_\infty - r_p) \times (K)^i \tag{79}$$

In the variable magnitude corrective impulse analysis, r was explicitly known and no approximation of its value had to be made for the time equation solutions.

Outbound Error Analysis

When the mission at the target planet has been completed, injection into the hyperbolic escape trajectory must be initiated. It will be assumed that the point of injection is known. The analysis, therefore, will be on the effect of an improper injection impulse. As in the inbound trajectory analysis, the idea of an error velocity will be used. In this outbound error analysis, no correction impulses will be applied to the spacecraft; the study will be on the resultant error velocity and position error at the sphere of influence. Since the return trajectory is the reflection of the trajectory to the target planet, the same magnitude of relative velocity is required at the sphere of influence that existed on the inbound trajectory. Therefore, the reference semi-major axis is known. It assumed that the circular orbital radius is known to the spacecraft crew.

Since a^R and r_p are known

$$e^R = \frac{r_p}{a^R} + 1 \tag{80}$$

$$b^R = a^R\left[(e^R)^2 - 1\right] \tag{81}$$

$$V_p^R = \left[\mu\left(\frac{2}{r_p} + \frac{1}{a^R}\right)\right]^{1/2} \tag{82}$$

$$h^R = r_p \times V_p^R \tag{83}$$

At the sphere of influence V_∞^R is known and ϕ_∞^R can be calculated by

$$\phi_\infty^R = \arcsin \frac{h^R}{V_\infty^R r_\infty} \tag{84}$$

The error velocity at pericenter must be added vectorally to the reference velocity, V_p^R. Let γ be the angle between these two velocity

vectors (clockwise rotation is positive) and the resultant velocity vector in component form would be

$$V_p^R + \delta V_p^E \cos\gamma \qquad \text{(longitudinal component)} \tag{85}$$

$$\delta V_p^E \sin\gamma \qquad \text{(transverse component)} \tag{86}$$

Due to the error velocity, the actual ϕ at pericenter is

$$\phi_p = 90^\circ + \arctan\left[\frac{\delta V_p^E \sin\gamma}{V_p^R + \delta V_p^E \cos\gamma}\right] \tag{87}$$

Since V_p and ϕ_p are known, the resultant trajectory parameters can be calculated

$$a = \frac{\mu r_p}{r_p V_p^2 - 2\mu} \tag{88}$$

$$h = r_p V_p \sin\phi_p \tag{89}$$

At the sphere of influence

$$V_\infty = \left[\mu\left(\frac{2}{r_\infty} + \frac{1}{a}\right)\right]^{1/2} \tag{90}$$

$$\phi_\infty = \arcsin\frac{h}{r_\infty V_\infty} \tag{91}$$

The change in ϕ is

$$\delta\phi = \phi_\infty^R - \phi_\infty \tag{92}$$

There are two other considerations, however, that effect the resultant velocity error at the sphere of influence even more. Any cross component of the error velocity will rotate the location of pericenter. Any longitudinal component of error velocity will change the curvature of the trajectory. These two effects must be included in the analysis. For an error velocity as shown in Fig. 6 the cross component causes the pericenter to rotate through an angle ω.

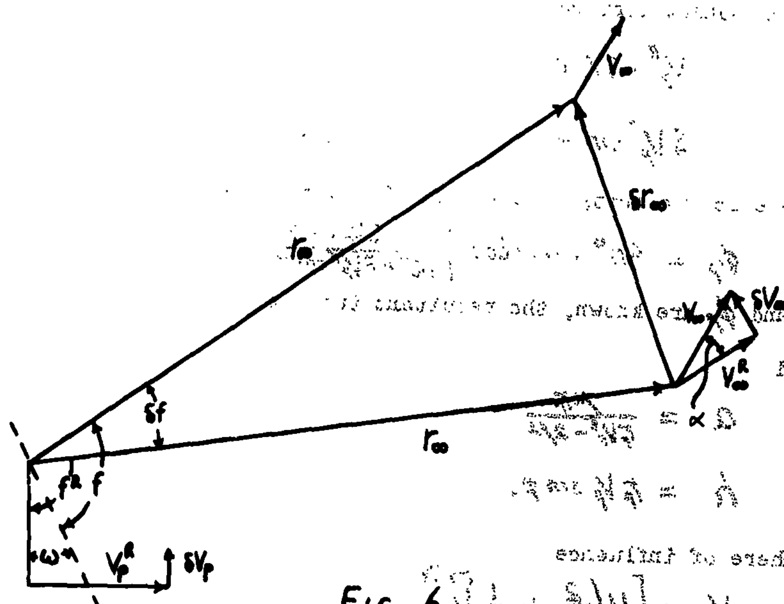


FIG. 6
OUTBOUND ERROR ANALYSIS

Since

$$\ell = a(e^2-1) \tag{93}$$

$$\cos\omega = \frac{1}{e}\left[\frac{\ell}{r_p}-1\right] \tag{94}$$

The true anomalies for both the reference and the actual trajectories at the sphere of influence are

$$\cos f^R = \frac{1}{e^R}\left[\frac{\ell^R}{r_\infty}-1\right] \tag{95}$$

$$\cos f = \frac{1}{e}\left[\frac{\ell}{r_\infty}-1\right] \tag{96}$$

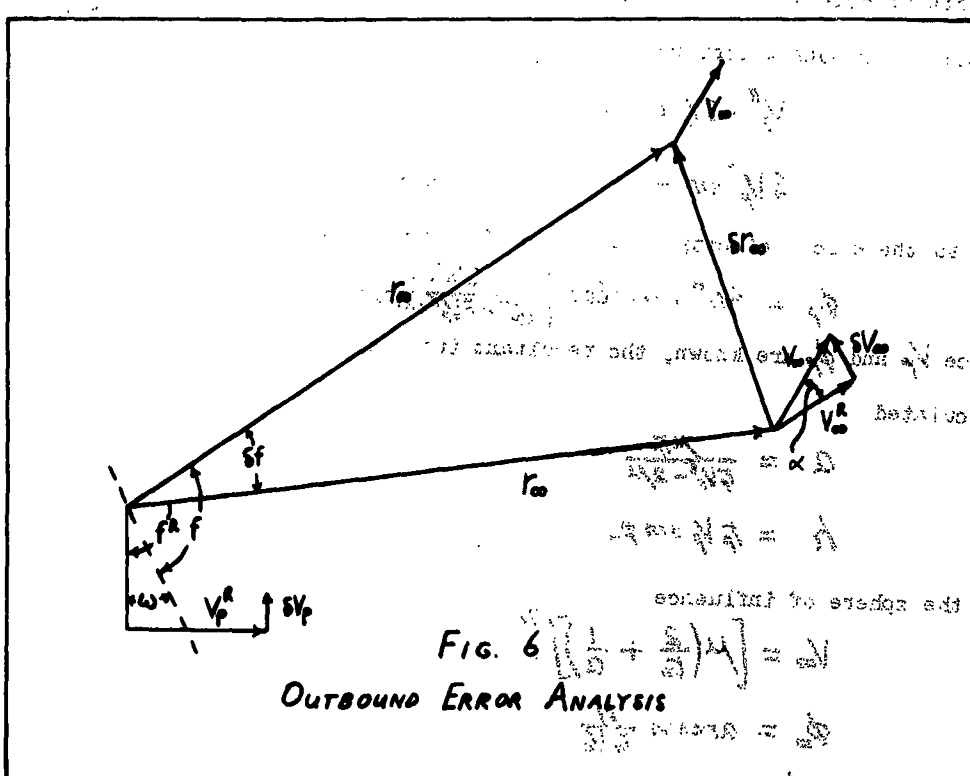


FIG. 6

OUTBOUND ERROR ANALYSIS

Since

$$\ell = a(e^2 - 1) \tag{93}$$

$$\cos\omega = \frac{1}{e}\left[\frac{\ell}{r_p} - 1\right] \tag{94}$$

The true anomalies for both the reference and the actual trajectories at the sphere of influence are

$$\cos f^R = \frac{1}{e^R}\left[\frac{\ell^R}{r_\infty} - 1\right] \tag{95}$$

$$\cos f = \frac{1}{e}\left[\frac{\ell}{r_\infty} - 1\right] \tag{96}$$

The components of the resultant error velocity at the sphere of influence are

$$\delta V_\infty^E(long.) = V_\infty \cos\alpha - V_\infty^R \qquad \text{(longitudinal component)} \qquad (97)$$

$$\delta V_\infty^E(trans.) = V_\infty \sin\alpha \qquad \text{(transverse component)} \qquad (98)$$

and the components of the position error are

$$\delta r_\infty(long.) = r_\infty(\cos\delta f - 1) \qquad \text{(longitudinal component)} \qquad (99)$$

$$\delta r_\infty(trans.) = r_\infty \sin\delta f \qquad \text{(transverse component)} \qquad (100)$$

where δf and α are

If $\delta V_p^E(trans.) < 0$ then $\delta f = f_\infty^R - \omega - f_\infty$ and $\alpha = \delta f + \delta\phi_\infty$ (101)

If $\delta V_p^E(trans.) = 0$ then $\delta f = f_\infty^R - f_\infty$ and $\alpha = \delta f + \delta\phi_\infty$ (102)

If $\delta V_p^E(trans.) > 0$ then $\delta f = f_\infty^R + \omega + f_\infty$ and $\alpha = \delta f + \delta\phi_\infty$ (103)

Part II

IV. Optimum 2-Stage Trajectory Problem

Purpose

The purpose of this problem is two-fold: (1) to determine a more optimum reference trajectory than the fixed reference trajectory described in the previous sections, and (2) to compare the results with those obtained previously to see if there is an appreciable decrease in the total impulse required.

Theory of Corrections

The reference trajectory used previously was the theoretical optimum trajectory for a one-stage correction. (Throughout the following sections this trajectory is referred to as the theoretical optimum trajectory.) When there was an error, all corrections were made in an attempt to attain the theoretical trajectory again. However, this required additional impulses. Theoretically, there should be some trajectory lying between the reference trajectory and the error trajectory where the combination of two impulses (one at orbit and one at the sphere of influence) is a minimum. This follows from the fact that as the impulse at the sphere of influence is increased to bring the trajectory closer to the reference trajectory the impulse needed at the orbit decreases. At some intermediate trajectory the trade-off between the two impulses will give an optimum value. This value and its corresponding trajectory is what this problem seeks to determine.

Assumptions

The specific assumptions which are made in the following analysis

are:

Orbital Range. A range of acceptable orbital radii will be allowed; this can be specified as input to the computer program. For a specific analysis in this thesis, 1.1 to 6.1 times the surface radius of the target planet is the allowable range.

Corrections. Only two corrections are made. The first is made at the sphere of influence toward the theoretical optimum trajectory, but a variety of magnitudes and directions of the impulse are allowed (this is explained in detail later, see pg. 39). The second correction is always made tangentially to the path at the pericenter of the resulting trajectory.

Errors. No errors are made in the corrections. This of course is not a realistic assumption, but since the analysis is intended only to give a comparison of the two methods of correction, if both are compared on the no-correction-error basis, the comparison should be valid. Further analysis of the effects of errors is given in Program 8.

Type of Trajectories. Only hyperbolic trajectories are analyzed between the sphere of influence and the orbit. The magnitude of the impulse required at the sphere of influence to reduce the trajectory to the parabolic energy level would be nearly the initial velocity, and an additional impulse would be required at orbit. However, the impulse required for the reference trajectory is only approximately .707 times the initial velocity, and small errors from the reference trajectory were anticipated to increase the total impulse by only a small percentage (this was borne out by the results). Therefore, any application of im-

pulse that reduces the trajectory to less than hyperbolic energy levels is bound to exceed the optimum value. The orbit is always circular and of radius equal to the pericenter distance of the transitional hyperbolic path.

Basic Equations

The basic equation used have been given previously, but they are repeated here for comparison with their normalized forms, which are used in the computed programs. The normalizations used are a localized system where distances are divided by the surface radius of the target planet, and the velocities are divided by the local circular velocity at the surface radius.

Circular Velocity. The circular velocity at any radius, r, is

$$V_c = \sqrt{\frac{G}{r}} \quad : \quad \tilde{V}_c = \sqrt{\frac{1}{R}} \quad , \text{ where } \quad \tilde{V}_c = \frac{V_c}{V_{cs}} \quad \& \quad R = \frac{r}{R_s} \;. \tag{104}$$

Escape Velocity. The local escape velocity at any radius, r, is

$$V_{es} = \sqrt{\frac{2G}{r}} \quad : \quad \tilde{V}_{es} = \sqrt{\frac{2}{R}} \quad . \tag{105}$$

Kinetic Energy. The kinetic energy equation (per unit mass) in terms of the radius, r, and the semi-minor axis of the hyperbola, a, is

$$V^2 = G\left(\frac{2}{r} + \frac{1}{a}\right) \quad : \quad \tilde{V}^2 = \frac{2}{R} + \frac{1}{A} \quad , \text{ where } \quad A = \frac{a}{r_s} \tag{106}$$

Angular Momentum. The equation for constant angular momentum (per unit mass) is

$$h = rV\sin\phi = r_oV_o \quad : \quad H = R\tilde{V}\sin\phi = R_o\tilde{V}_o \tag{107}$$

Total Energy. The equation of total energy (per unit mass) in terms of kinetic and potential energy is

$$E = \frac{V^2}{2} + \frac{G}{r} \quad : \quad \tilde{E} = \frac{\tilde{V}^2}{2} + \frac{1}{R} \tag{108}$$

<u>Theoretical Optimum Trajectory</u>. The theoretical optimum trajectory parameters are

$$r_o^* = \frac{2G}{V_{INF}^2} \quad : \quad R_o^* = \frac{2}{\tilde{V}_{INF}^2} \tag{109}$$

$$\Delta V_o^* = \frac{V_{INF}}{\sqrt{2}} \quad : \quad \Delta\tilde{V}_o^* = \frac{\tilde{V}_{INF}^2}{\sqrt{2}} \tag{110}$$

$$V_o^* = \sqrt{2}\, V_{INF} \ : \quad \tilde{V}_o^* = \sqrt{2}\, \tilde{V}_{INF} \quad \text{and} \quad e^* = 3 \tag{111}$$

<u>Hyperbolic Parameters</u>. Pertinent relationships of the hyperbolic conic parameters are

$$l = a(e^2-1) = \frac{h^2}{G} \quad : \quad L = A(e^2-1) = H^2 \tag{112}$$

<u>Computer Program 7</u>

The flow diagram for Program 7 is shown on page 36, and provides a concise clear picture of how the program is constructed. The actual program is more difficult to follow and is included in Appendix B .

<u>Input Data</u>. The elements of data which are supplied to the program as input data are as follows:

HEAD --the heading for the problem

G --the target planet's gravitational constant

V_{IN} —the initial velocity (velocity relative to the target planet at the sphere of influence)

R_{IN}--the initial radius (radius of the sphere of influence)

R_S --the target planet's surface radius

ϕ_{IN}--the first trial path angle considered for an initial condition

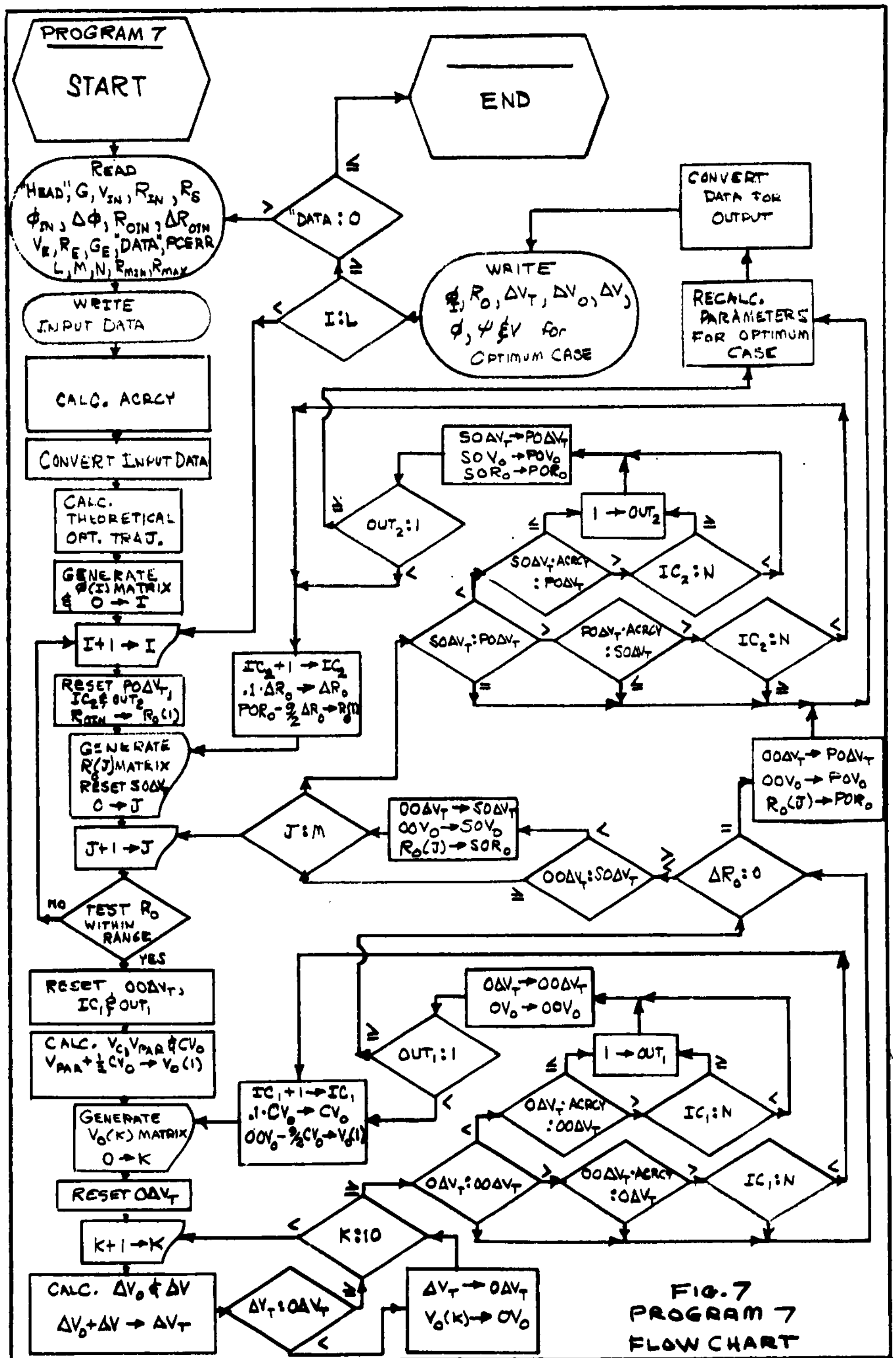


FIG. 7
PROGRAM 7
FLOW CHART

$\Delta\phi$ --increment between path angles in the initial condition set

R_{OIN}--the first trial orbital radius

ΔR_{OIN}--the increment between trial orbital radii

V_E --the circular velocity of the earth about the sun

r_E --the radius of the earth

G_E --the gravitational constant of the earth

$O\Delta V_I$ --the initial value for the optimum sum storage cells

IC_I --the initial value for the iteration counter

$NORM_1$ --normalization indicator for input, $NORM_1 > 0$ indicates normalized input

$NORM_2$ --normalization indicator for output, $NORM_2 > 0$ indicates normalized output

L --number of initial condition sets

M --number of radii in radius grid

N --the limiting number of iterations allowed in each loop

PCERR --percentage of test value for convergence

R_{MAX} --maximum allowable orbital radius

R_{MIN} --minimum allowable orbital radius

DATA --number of sets of data remaining after the one being processed

This program allows two systems of input data: the primary one is a normalized system and the other uses kilometers and seconds as units. In the normalized system the planet constants are normalized with respect to the earth constants:

$$\hat{R} = \frac{r_s}{r_{s_E}} \qquad (r_{s_E} = 6370 \text{ km.}) \, , \tag{113}$$

$$\hat{G} = \frac{G}{G_E} \qquad (G_E = 3.990(10)^6 \text{ km}^3/\text{sec}^2) \, , \tag{114}$$

$$\hat{V}_{IN} = \frac{V_{IN}}{V_E} \qquad (V_E = 29.8 \text{ km/sec}) \, . \tag{115}$$

But, the local distances are normalized with respect to the surface radius of the target planet:

$$R_{IN} = \frac{r_{IN}}{r_s} \, , \quad R_{O_{IN}} = \frac{r_{O_{IN}}}{r_s} \quad \& \quad \Delta R_{O_{IN}} = \frac{\Delta r_{O_{IN}}}{r_s} \, . \tag{116}$$

All angles in the input and output are in degrees, but are converted in the program to radians for use in computer subroutines, and are then reconverted for output.

The input data from both systems is converted to a completely localized system for computations. The latter system was explained previously (see pg. 34) and uses r_s and V_{cs} as bases for normalized distances and velocities.

<u>Theoretical Optimum Trajectory</u>. The program computes and outputs the results of the theoretical optimum trajectory calculations which were described in detail earlier (see pg. 5) and are not repeated here. The impulse required for this trajectory is used as a standard of comparison for all other impulse sums. The ΔV's are divided by this value for output.

<u>Iteration Principle</u>. The calculations of the trajectory are made

in reverse (as an outgoing trajectory) to obtain a simple iteration procedure. For each initial condition the orbital radius and a velocity of ejection from circular orbit are selected; the difference between the chosen ejection velocity and the circular velocity is the impulse needed at the orbit. Then the conditions for this particular trajectory at the sphere of influence are calculated and compared with the initial conditions given in the problem. The difference in velocity vectors is the velocity necessary at the sphere of influence to attain the originally selected orbit. The sum of the magnitudes of the impulses at the sphere of influence and at the orbit is the same for either the outgoing or the incoming trajectories; only the directions of application are different.

For each particular orbital radius chosen, a set, or grid, of ten different ejection velocities is selected. The velocity grid is chosen to span trajectories with energy contents of slightly greater than parabolic to hyperbolic with a velocity V_{IN} at infinity. Any trajectory of greater energy content than the later will certainly not be optimum, since it would involve an addition of energy which would just have to be countered during the orbital correction. Therefore, the optimum ejection velocity for the particular radius chosen will certainly lie somewhere within the grid. The calculations previously described for the sum of impulse are made for each velocity of the grid. The velocity in the grid corresponding to the minimum sum of impulses is used as the center point for a new velocity with one-tenth the span of the first grid. The process is repeated and the optimum point of the second grid is used as a center point for the third grid, which has one-tenth the span of the

second grid. This iteration process is repeated until successive minimum impulse sums have converged to the desired accuracy. The accuracy requirement is specified by input data. (0.01% change was the requirement for data in this thesis.) The final result is an optimum impulse sum and corresponding ejection velocity.

If a desired orbital radius is specified for the trajectory, the iteration process would be terminated at this point; however, if a range of orbits is allowed, the above procedure is repeated for each of ten radii in an orbital-radius grid. Each radius in the grid, which spans the allowable radius range, will have an optimum impulse sum and corresponding trajectory. There will be one radius that will correspond to the trajectory having the overall minimum impulse sum. This radius is in turn used as the center point for a second radius grid with one-tenth the span of the first. The radius-iteration process continues and is terminated in the same manner as the velocity-iteration process was. The final result of the complete iteration process is an overall optimum impulse sum and the corresponding orbital radius and ejection velocity. From these quantities any of the parameters of the optimum trajectory can be computed.

<u>Iteration</u> <u>Calculations</u>. The actual calculations for the iteration processes are described briefly below. Hereafter, unless otherwise specified, all velocities are locally normalized and the "~" has been dropped.

A set of initial conditions at the sphere of influence is generated by the program, where each condition has the same velocity magnitude but a different path angle. The first condition has a path angle determined

from input data:

$$\phi_{I_1} = \phi_{IN} \tag{117}$$

Each successive angle is:

$$\phi_{I_n} = \phi_{I_{n-1}} + \Delta\phi \tag{118}$$

The radius grid is determined by input data which states the initial orbital radius and the increment between grid radii. The computer computes the grid accordingly; the first radius is

$$R_{O_1} = R_{OIN} \tag{119}$$

and each successive radius is

$$R_{O_i} = R_{O_{i-1}} + \Delta R_O \tag{120}$$

The velocity grid is also determined from input information, the initial velocity, and from the grid radius which is presently being considered (each different grid radius will have a different velocity grid). The local escape velocity at the grid radius defines the lower limit of the ejection velocity, as this corresponds to a parabolic trajectory.

$$V_{ES} = V_{PAR} = \sqrt{\frac{2}{R}} \tag{121}$$

The ejection velocity necessary to give the vehicle a velocity of V_{IN} at infinity is

$$V_O = \sqrt{V_{IN}^2 + V_{PAR}^2} \quad . \tag{122}$$

since $V_O = V_{PAR}$ will give it a velocity equal to zero at infinity.

For ten equally spaced velocities, or nine increments, between the two limits, the grid increment or change is

$$CV_o = \frac{\sqrt{V_{IN}^2 + V_{PAR}^2} - V_{PAR}}{9} \tag{123}$$

To assure hyperbolic paths, the first grid point is taken slightly higher than the parabolic velocity,

$$V_{o_1} = V_{PAR} + \frac{1}{2} CV_o \tag{124}$$

and each successive velocity is greater than the previous by ,

$$V_{o_i} = V_{o_{i-1}} + CV_o \tag{125}$$

This means that the tenth velocity will be slightly greater than the upper limit calculated before, but this is of little consequence, since the main concern is that the grid span all velocities which might possibly be the optimum.

Impulse-Sum Calculations. The order in which calculations are done in the program is governed by the parameters on which they depend. All elements which can be determined from only the initial conditions are calculated first, so that they will not be repeated many times in the loops. Next, the elements involving the orbital radius are c[illegible]ated so that they will not be repeated in the velocity loops. And finally the calculations involving the velocities are made.

The potential energy at the sphere of influence is based only on the initial radius: $PE = 1/R_{IN}$.

The circular velocity at orbit is based only on the orbital radius: $V_c = (1/R_o)^{1/2}$.

Several calculations depend upon the selected ejection velocity. The impulse at orbit is

$$\Delta V_o = V_o - V_c \quad , \tag{126}$$

and the resulting trajectory parameters are

$$\frac{1}{A} = V_o^2 - V_{PAR}^2 \tag{127}$$

and

$$H = R_o V_o \tag{128}$$

The conditions of the resulting trajectory at the sphere of influence are

$$V = \sqrt{\frac{1}{A} + 2PE} \tag{129}$$

and

$$\phi = \arcsin\left(\frac{H}{R_{IN} V}\right) \tag{130}$$

The impulse at the sphere of influence is determined by trigonometric rather than geometric relationships, since the geometric cosine law involves subtracting numbers of nearly equal magnitudes, and therefore a possibility of large errors. The change in path angle is $\Delta\phi = \phi - \phi_{IN}$. The longitudinal and cross components of the corrected velocity (see Fig. 8) are $V_{LG} = V\cos\Delta\phi$ and $V_{CR} = V\sin\Delta\phi$.

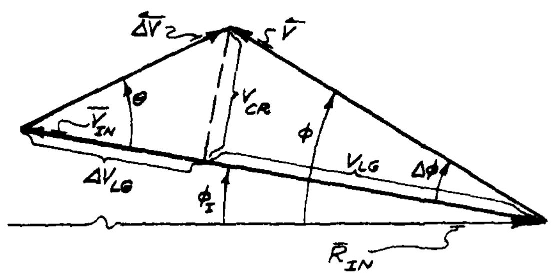


FIG. 8
VELOCITIES AT THE
SPHERE OF INFLUENCE

Then $\Delta V_{LG} = V_{IN} - V_{LG}$ and $\theta = \arctan(V_{CR}/\Delta V_{LG})$, so that the magnitude of the impulse at the sphere of influence is $\Delta V = |V_{CR}/\sin\theta|$.

The absolute value is taken so that all impulses are additive. The sign is significant only for vector orientation. This is a necessary consideration for determining the correction angle (see pg. 47), but at the present only the calculations are made which are necessary to find the total sum of impulses for each case. The remaining parameters, such as the correction angle, are calculated after the optimum trajectory has been determined. This procedure eliminates the calculation of some parameters for the nonoptimum cases.

Optimum Selection Procedure. The general optimum-selection procedure is accomplished by comparing the most recent value of the impulse sum with the optimum of all preceeding sums. If the recent value is less it replaces the old optimum. Before the first calculation is made, a very large number is placed in storage as the optimum value so that the first sum is certain to be smaller, and hence be selected as the current optimum.

Since the optimum sums of consecutive iterations are used to test convergence in the program, this optimum selection process must be used at four points: (1) the optimum-impulse sum for each velocity grid with a specific R_o is selected, (2) this is compared to "old optimum", which is optimum for all previous grids with the same R_o, (3) the "old optimum" is checked against the "subsequent optimum", which is the least value for all velocity grids of all previous orbital radii in the same radius grid, and (4) the "subsequent optimum" is compared to the "previous optimum", which is the overall optimum for all previous radius grids. Therefore, when the last set of R_o's have been analyzed, the

value in the "previous optimum" storage position is the optimum value for all trials. If a specific orbital radius were desired, the radius grid could be eliminated (this can be done with this program by specifying these inputs: $\Delta R_o = 0$ and $R_{OIN} = R_{MAX} = R_{MIN} = R$ and only the first two optimum selection processes would be required. For a zero ΔR_o, the program will transfer the "old optimum" value to the "previous optimum" storage position for output.

Convergence Test. The convergence test that is used to terminate the iteration loops specifies a maximum percentage difference between consecutive optimum sums. The difference in sums must be less than the specified percentage, which is based on the lower of the two sums, to obtain greater convergence. In this thesis analysis 0.01% (or 0.0001) was used as a convergence limit. A very small percentage was used since the degree of convergence and the degree of error do not necessarily correspond. For example: the true optimum value (if it were known) might be 1.8772, while consecutive iterations yeilded 1.8000, 1.9000, 1.8800, 1.8785, 1.8781, 1.8778, 1.8776, and 1.8776. Since the difference between the last two values is less than 0.01% the computations would be terminated, but the error would be greater than 0.01%. However, if the computations were continued the true value might be obtained: 1.8774, 1.8773, 1.8773, and 1.8772. Even the fact that two consecutive values correspond does not mean that the true optimum has been reached, since the true value may lie approximately half way between the two.

In addition to the convergence test an iteration-count test is used as a safeguard against indefinite looping if erroneous data is

picked up somewhere in the program. The limiting number of iterations can be specified as input data, N , and in this case 10 was used since trial cases showed that normally no more than 4 or 5 loops were made for necessary convergence.

Trajectory Calculations. After the optimum trajectory has been selected, the trajectory parameters are recomputed, since only V_o and R_o of the optimum trajectory are stored during iterations. Although it would be possible to store a table of all the trajectory parameters for the optimum case, the many transfers of data into the table would require more time and more storage space than just recomputing the few parameters for the optimum case.

After the parameters which were previously described are recomputed, the correction angle is calculated. Special consideration of the correction is required since the 7090 Computer subroutine for the arctangent yields only 1st and 4th quadrant angles ($-\pi$ to $+\pi$), and the thetas in the program may be in any of the four quadrants. Therefore, when ΔV_{LG} is negative, pi is subtracted from theta to give the desired 2nd or 3rd quadrant angle. This is illustrated in Table III. Although adding pi to theta would give an equivalent angle, it is subtracted here, since theta is later subtracted during the calculation of psi:

$$\psi = \pi - \Theta + \phi_I \tag{131}$$

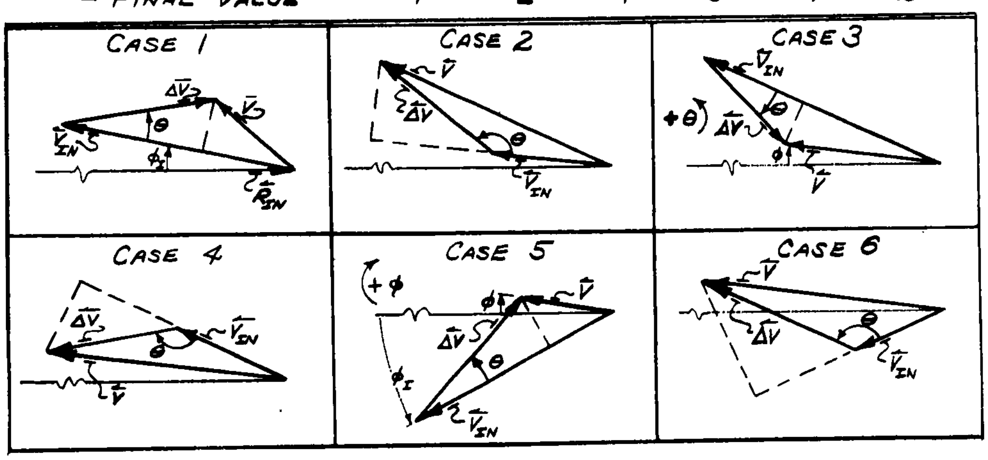
By this convention psi will normally be less than pi in magnitude.

Output Data. All input data to the program is also written out in the form in which it was entered; this provides a convenient reference and a check on proper insertion of data. The remainder of the output

TABLE III

CORRECTION ANGLE DETERMINATION

TRAJECTORY PARAMETERS	CASE 1	CASE 2	CASE 3	CASE 4	CASE 5	CASE 6
	RELATIVE VALUES (++ > + > −)					
ϕ	−−	++	+	+	+	+
ϕ_I	+	+	++	++	−	−
$\Delta\phi = \phi - \phi_I$	+	+	−	−	+	+
V_{IN}	++	+	++	+	++	+
$V_{LG} = V\cos\Delta\phi$	+	++	+	++	+	++
$\Delta V_{LG} = V_{IN} - V_{LG}$	+	−	+	−	+	−
$V_{CR} = V\sin\Delta\phi$	+	+	−	−	+	+
$\tan\theta = V_{CR}/\Delta V_{LG}$	+	−	−	+	+	−
QUAD. OF θ — FROM SUBPROGRAM	1ST	4TH	4TH	1ST	1ST	4TH
QUAD. OF θ — $-\pi$ for $-\Delta V_{LG}$	~	$-\pi$	~	$-\pi$	~	$-\pi$
QUAD. OF θ — FINAL VALUE	1ST	2ND	4TH	3RD	1ST	2ND



data can be converted to either of the two systems of units described for the input data. In normalized system, however, the ΔV's are further normalized with respect to ΔV^*. This expresses the impulses as a percentage of the theoretical-optimum impulse. The output information for the optimum trajectory is as follows:

ϕ_r --the initial path angle

R_o --the orbital radius

ΔV_T --the sum of impulses

ΔV --the first impulse, at the sphere of influence

ΔV_o --the second impulse, at the orbit

ϕ --the path angle after the first correction

ψ --the angle of the first correction impulse with respect to the radius vector

and V --the velocity after the first correction

The most significant results are given on pgs.100-106, and other results are given in Appendix B .

Finally, the program tests the value of "DATA" from the input; this is a number which indicates the number of sets of data left to process. If the number is zero, the program is terminated; if it is not zero, the next set of input data is read and the whole program is repeated. This procedure eliminates loading the program into the computer for each separate problem; as many problems as desired can be run sequentially.

V. Optimum Trajectory for a Range of Orbits

Purpose

This problem is a continuation of the last problem; it is also based on an allowable range of circular orbits. The objective of this problem is to use the correction of Program 7 as a starting point and to determine an optimum sequence of corrections from there to the orbit when errors in each correction are assumed. The purpose also includes a comparison of the results of this method with those from the Multi-step Optimization Problem and the Multi-step Reduction Problem.

Theory of Correction Sequence

If the same logic behind Program 7 were applied throughout the sequence of correction which involves errors, there would be no fixed reference trajectory since each step would have a different optimum reference trajectory computed by Program 7. The optimum reference path at any radius would depend upon what each of the preceeding errors and optimum paths had been. This method might work well in actual application where a computer on the spacecraft is used to determine the best correction sequence, rather than having it all precomputed for a statistical error distribution. The logical point at which to make each correction would be determined by the following method:

(1) The optimum 2-correction path is calculated periodically by Program 7,

(2) the worst expected error is added to the calculated optimum correction and the resulting trajectory parameters are calculated,

(3) the impulse required at orbit for the resulting trajectory would be added to the optimum correction impulse,

(4) the impulse required at orbit for the actual trajectory which the spacecraft is now on would be computed, and

(5) the impulse sum from (3) would be compared to the impulse from (4); if the latter is smaller a correction would not be made at this time, but if it is larger a correction is certain to be more optimum.

The above method would be fairly simple where the actual errors after each correction would be known. But for a hypothethetical problem using statistical errors it becomes extremely complicated, since the effects of the individual errors are not independent. The directions as well as the magnitude affect the impulse sums.

Therefore, in this problem the correction sequence has been simplfied by always attempting to correct to the original optimum reference trajectory. Since the direction of the error is very significant when a range of orbits is allowed, and "envelope" of error trajectories is used. First the errors are all assumed to increase the pericenter distance (outer errors), and then the analysis is repeated with errors that decrease the pericenter distance (inner errors). This envelope will give the extremes of impulses required to compensate for errors.

Assumptions

Orbital Range. As in the previous problem, the acceptable range

for orbits is assumed to be 1.1 to 6.1 times the surface radius of the target planet.

Programmed Mission Orbit. The programmed mission orbit (the aiming point for the midcourse guidance) is assumed to be the theoretical optimum trajectory orbit when it lies within the acceptable range. If the theoretical orbit lies above the range, the outer range limit is used as the programmed orbital radius, and if the theoretical orbit lies below the range, the programmed radius is the inner range limit.

Midcourse Error. There is an initial error at the sphere of influence that is caused by errors in midcourse guidance. For the purposes of this analysis an error equal in magnitude to 10% of the velocity and directed perpendicular to the velocity vector is assumed, since that is the direction causing the most significant effect on the orbital radius. Also, the perpendicular error assumption is consistent with the previous programs.

Reference Trajectory. From the initial conditions (the programmed trajectory plus the midcourse error), an optimum reference trajectory is selected by the analysis of Program 7. All subsequent corrections are made in an attempt to attain the reference trajectory.

Correction Errors. An error in each correction impulse is assumed, and for this analysis the value of 1% of the reference trajectory velocity at the correction radius is used. Since a range of orbits, which is not necessarily symmetrical with respect to the reference trajectory, is allowed, the directions as well as the magnitudes of the errors are important. The worst combinations of errors will occur when all of the

errors are in the same direction; therefore, an envelope of errors is used to determine the worst possible error conditions. First, the errors are all assumed to be "outer errors," which increase the pericenter distance. Then the errors are all assumed to be "inner errors," which decrease the pericenter distance. For consistency with the assumptions in previous problems, the correction errors are all assumed to be cross-component errors. Since this results in a very small error angle, $\delta\phi$, its cosine is assumed to be very nearly unity, and the change in velocity magnitude is negligible.

Number of Corrections. The number of corrections was originally limited to 15, since previous analysis showed that optimum number is likely to be less than this. Preliminary results from Program 8 indicated that it would probably be much less than 15 when a range of orbits is allowed; therefore, the limit was reduced to 10.

Orbital-Range Tolerance. Because a range limit may be chosen as the reference trajectory, none of the error trajectories to the outside of the reference will be in the allowable range. Therefore, a range-limit tolerance is allowed for the error trajectories. This tolerance, within which the final erroneous orbit must lie, is assumed to be 10% of the altitude of the orbit above the planet's surface.

Type of Trajectory. Once again the trajectories between the sphere of influence and the orbit are assumed to be hyperbolic, while the orbit is circular.

Basic Equations

The basic equations used in this analysis are the same as used in

Program 7 (see pgs. 34-35) and are not repeated here.

Computer Program 8

Program 8 is divided into a main program and four subprograms. The main program is explained first and the functions of the subprogram are stated. The details of each subprogram are explained later. The flow chart for Program 8 is on page 5 .

Input Data. The input data for this program is allowed only one form, which is the same form as the normalized input to Program 7. The input data is also converted to the locally-normalized system within the program, as in Program 7.

Theoretical Optimum Trajectory. The calculations of the theoretical-optimum-trajectory parameters is also included in the program. The details of the calculations have been given on page 5.

Sequence of Computations. First, the programmed mission orbit is determined in accordance with the assumptions and the value of R_o^*, the theoretical-optimum orbital radius. If one of the orbital-radius-range limits is selected as the reference orbit, the corresponding initial conditions at the sphere of influence must be determined. This determination is made by the Subroutine RTRAJ. If the theoretical optimum is selected for reference, the initial conditions have already been determined.

The outer-error analysis is made first, and begins at this point. The outer limit of the radius-range tolerance is calculated by the formula

$$R_{LIM} = R_{MAX} + R_{ERR}(R_{MAX} - 1) \tag{132}$$

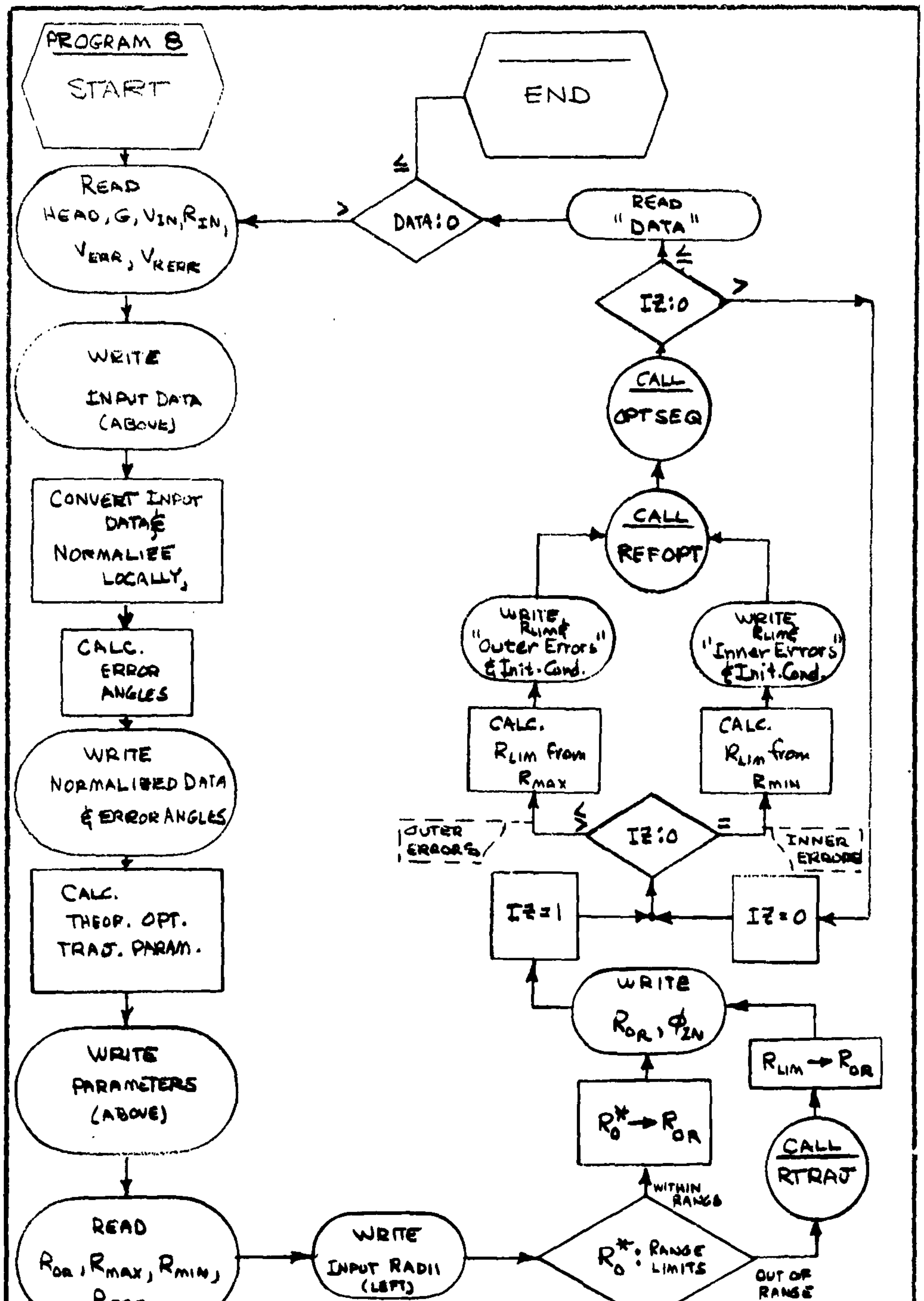


FIG. 9
PROGRAM 8 FLOW CHART

Next the initial error is added to the initial conditions to determine a new set of initial conditions including the error:

$$V_I = \sqrt{V_{IN}(1+V_{ERR}^2)} \tag{133}$$

$$\phi_I = \phi_{IN} + \phi_{ER} \tag{134}$$

where ϕ_{ER} has been previously determined in the program as

$$\phi_{ER} = \arctan(V_{ERR}) \tag{135}$$

This new set of initial conditions is given to the Subroutine REFOPT for calculation of the optimum reference trajectory.

Using the reference trajectory, the Subroutine OPTSEQ computes the optimum correction sequences for one to ten-stage sequences.

The last part of the program is now repeated for inner errors starting with the computations of the inner limit of range tolerance:

$$R_{LIM} = R_{MIN} - R_{ERR}(R_{MIN}-1) \tag{136}$$

After the inner-error sequences have been determined, the program will be terminated if no other sets of input data remain to be calculated. If the results of more than one set of input data are desired, the input parameter "DATA" is set positive, and the entire program will be repeated.

Output Data. As a convenience and for a check on the proper insertion of input data, all significant input data is written out in the same form in which it was entered. (The limits on I and N, the number of correction radii and the number of corrections was not considered significant since it is apparent from the results which are written out.

The results are written out immediately following the completion of each phase of the program, since the 7090 Computer can calculate while outputing information. This procedure reduces the running time of the program. Many of these outputs are in the subroutines themselves, and consequently are described in the details of the subroutines.

In general the form of the output data is the normalized system where the ΔV's are normalized by ΔV^* and the R's by R_S. The final angle calculations are written out in degrees as indicated in the results by "(D)" following the angle name. At a few points intermediate angle results are given in radians, with no indication of units.

The output parameters from the main program are

V_{cs}--local circular velocity at the radius R_S,

R_S--the surface radius of planet,

V_{IN}--the initial velocity of the spacecraft relative to the planet

ϕ_{ER}--the initial path-angle error,

$\delta\phi$--the path-angle correction-error,

R_o^*--the theoretical optimum orbital radius, in both dimensional and non-dimensional form,

ΔV^*--the theoretical optimum impulse, in both dimensional and non-dimensional form,

ϕ^*--the theoretical optimum path angle at the sphere of influence, in both dimensional and non-dimensional form,

R_{OR}--the reference trajectory orbital radius,

ϕ_{IN}--the reference trajectory path angle at the sphere of influence, in both dimensional and non-dimensional form,

R_{LIM}--the tolerance-limit for the orbital range, either for inner or outer errors, depending upon the current phase of the analysis,

V_I --the initial velocity including midcourse error, and

ϕ_I --the initial path angle including error

Subprograms

The four subroutines which are used in Program 8 are described in the order in which they are called for in the programs.

Subroutine RTRAJ. This routine is used to calculate the initial conditions at the sphere of influence when one of the range limits is selected as the programmed orbit. Since the velocity at the sphere of influence for the programmed trajectory is assumed to be equal to V_{IN}, only the initial path angle must be determined. This program assumes various pericenter velocities for trial trajectories with a pericenter distance of R_{LIM} and attempts to match the velocity at the sphere of influence to V_{IN}. The flow chart for RTRAJ is on page 58.

The input parameters from the main program to the subroutine are the orbital radius, R_{LIM}, and the initial conditions at the sphere of influence: R_{IN}, V_{IN}, and PE2(two times the potential energy).

Since the computations involve an iteration process, the final result is an approximation and a criterion of accuracy must be specified. In this case, finally computed value of velocity at the sphere of influence must not differ from V_{IN} by more than 0.01%, $V_{LIM} = 0.0001\, V_{IN}$.

A starting point is determined for the iteration process by selecting a trajectory of somewhat greater energy content than that of

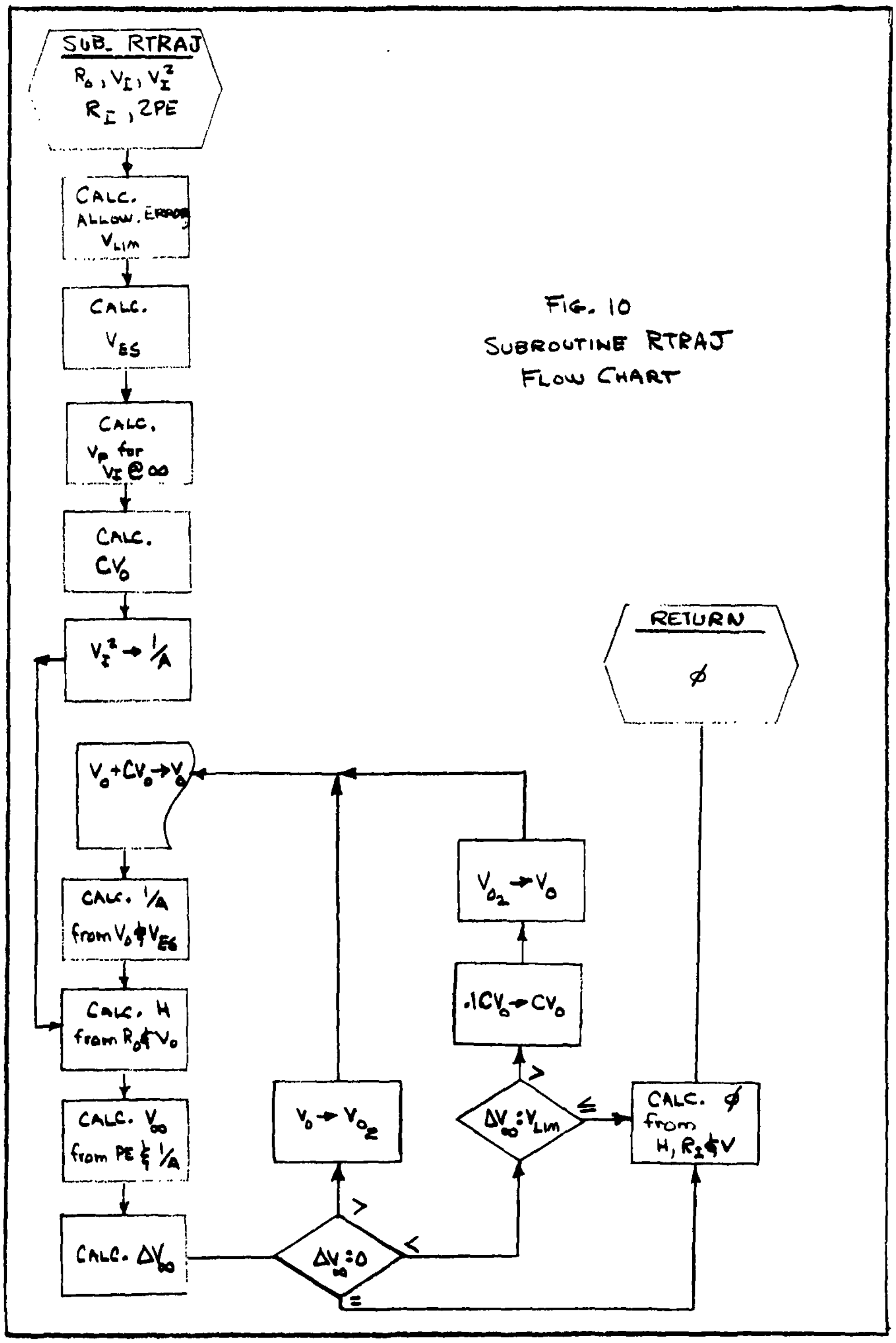


FIG. 10
SUBROUTINE RTRAJ
FLOW CHART

desired trajectory. The pericenter velocity corresponding to this starting trajectory is then decreased in increments until the trajectory becomes close to that desired. The size of the increments is then decreased in successive steps, until the accuracy criterion is met. The path angle at the sphere of influence can be calculated from the parameters of the desired trajectory.

The trajectory selected for the starting point has an energy content represented by

$$V_{INF}^2 = V_{IN}^2 \tag{137}$$

In general the energy content of a trajectory would be represented by

$$V_{INF}^2 = \frac{1}{A} = V^2 - \frac{2}{R} \tag{138}$$

and the desired trajectory has

$$V_{INF}^2 = V_{IN}^2 - \frac{2}{R_{IN}} \tag{139}$$

which is less than that of the starting trajectory. The pericenter velocity for the starting trajectory will be

$$V_o = \sqrt{V_{INF}^2 + \frac{2}{R_o}} = \sqrt{V_{IN}^2 + V_{ES_O}^2} \tag{140}$$

For the initial iteration it will be decreased in a series of steps by an increment of $CV_o = (V_o - V_{ES})/9$. During each step the value of at the sphere of influence is calculated by the equations:

$$\frac{1}{A} = V_o^2 - \frac{2}{R_o} = V_o^2 - V_{ES}^2 \tag{141}$$

$$V = \sqrt{\frac{1}{A} + 2PE} \quad , \qquad \text{where} \quad PE = \frac{1}{R_{IN}} \tag{142}$$

For the starting trajectory, $\Delta V = V - V_i$ will be positive, and as decreases with each successive trial ΔV will eventually become

negative. After a negative value is obtained, the process will be terminated if ΔV is less in magnitude than V_{LIM}. If ΔV is larger, a new series of steps is performed starting with the V_0 that immediately preceeded the one that caused ΔV to be negative. Also the increment is decreased to one-tenth the previous increment. This iteration procedure in continued until $|\Delta V| \leq V_{LIM}$, and then the initial-condition path angle is computed from the parameters of the final trial trajectory:

$$\phi = \arcsin\left(\frac{H}{R_{IN} V}\right) \tag{143}$$

This value is the only output parameter to the main program.

Subroutine REFOPT. The subroutine REFOPT is basically the same as Program 7. The initial conditions which have been determined in the main program are input to this subprogram, which determines the optimum correction to make at the sphere of influence. The details of the subroutine are not described here as most of them would be repetitions of those for Program 7; only the differences between the two programs will be noted. The flow chart is on page 61.

Many of the constants, such as V_E, G_E, R_E, etc., are written into the program rather than being entered as input data. Also, some of the variables have been more conveniently named (i.e. F_1 & F_2 for ODVT & OODVT, etc.). But, the most significant changes are in the input and output to the subprogram.

Since the subprogram does not generate its own conditions, as does Program 7, and single set of initial conditions is entered from the main program. The input arguments from the main program to the subroutine are: V_I, V_I^2, ϕ_I, R_I, R_{MAX}, R_{MIN}, ΔV^*, and PEZ . The

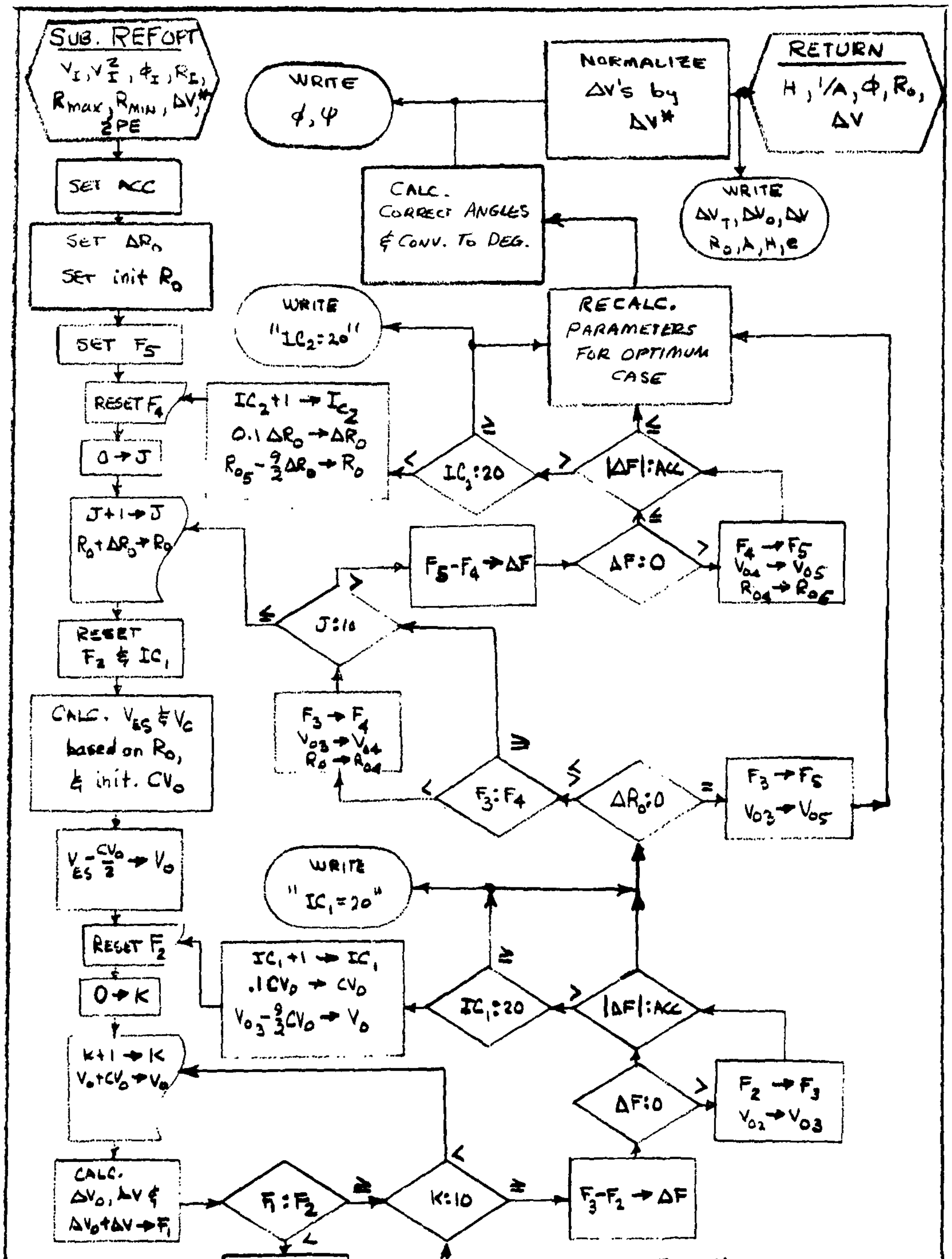


FIG. 11
SUBROUTINE REFOPT
FLOW CHART

output arguments to the main program from the subroutine are the optimum reference trajectory parameters: $1/A$, ϕ, R_o, and ΔV (at the sphere of influence). In addition the subprogram writes out the following parameters: ΔV_T, ΔV_O, ΔV, A, H, ϕ, ψ, θ, and e.

Subroutine OPTSEQ. The subroutine OPTSEQ utilizes the concept of dynamic programming in a similar manner as Program 5. Its purpose is to calculate the optimum sequence of corrections when each correction is in error. The flow chart for this subprogram is on pg. 63, and may be of help in understanding the program, which contains many loops and therefore tends to be quite confusing.

The input arguments from the main program are: the reference-trajectory parameters; R_{IN}, R_{OR}, H_R, and $1/A_R$; the selected tolerance limit, R_{LIM} the correction error angle, $\delta\phi$; the inner-or-outer-error indicator, IZ ; the theoretical optimum impulse, ΔV^*; and ΔV at the sphere of influence. The subroutine also reads input data i_L and n_L, the limits on the number of correction radii and on the number of corrections.

The first step in this subroutine is to call Subroutine RMATX. This subroutine calculates and stores in memory a table of information for each correction radius. Since the table contains information which is used many times in the program, a large amount of time is saved by calculating each item once and storing the information for later use. For each possible correction radius the table contains the reference trajectory parameters R, ϕ_R, V_R, and $PE2_R$; and also the H for a trajectory which has been corrected at that particular radius (in other

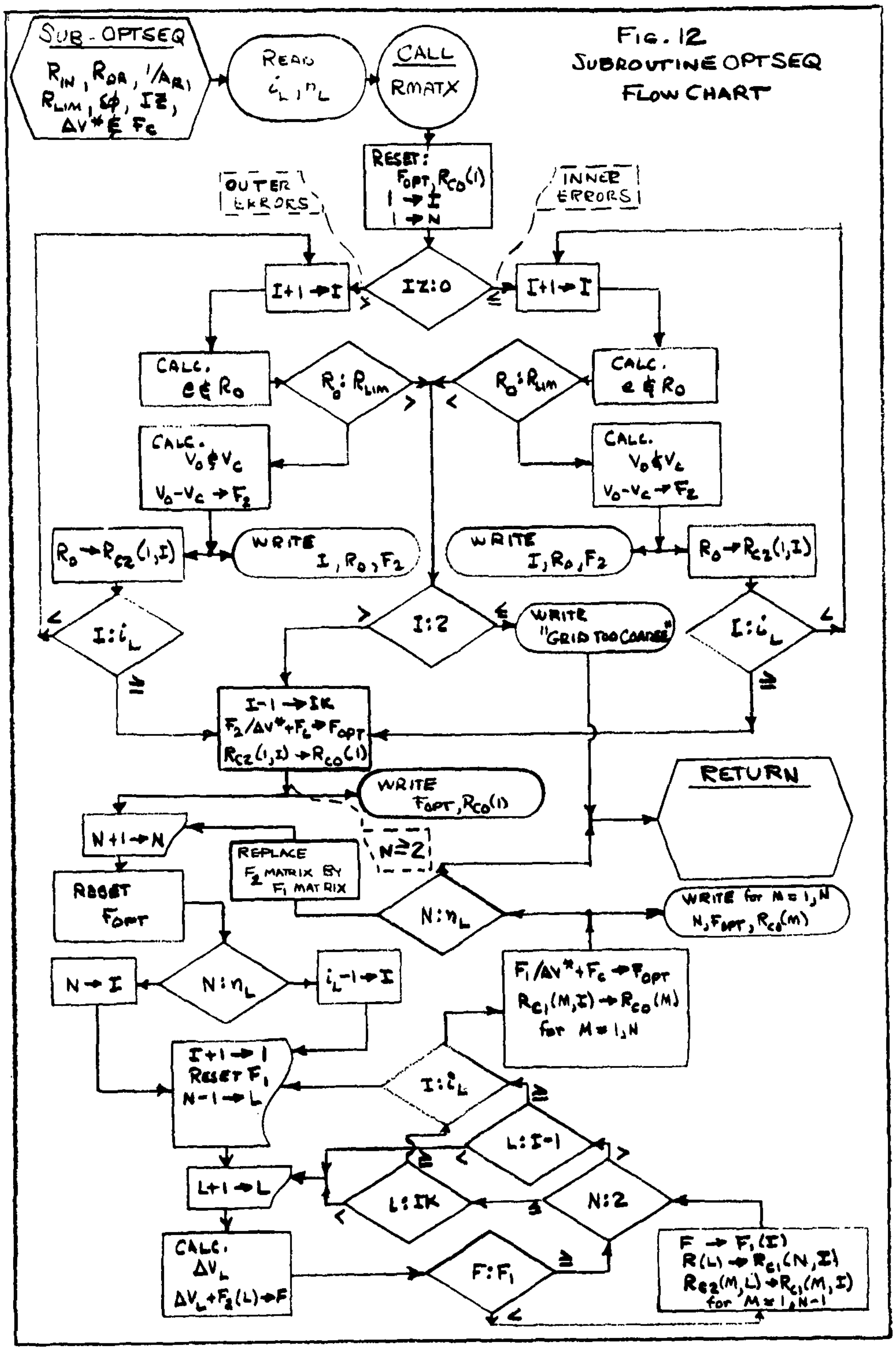


Fig. 12
SUBROUTINE OPTSEQ
FLOW CHART

words, for the trajectory that makes an angle of $\delta\phi$ with the reference trajectory. This trajectory is illustrated in Fig. 13; H_2 is the angular momentum of trajectory #2. If a correction is made at R_2, regardless of what the previous trajectory was, the conditions after correction will be those corresponding to trajectory #2. The angular orientation of the radius vector in space is immaterial; therefore, any of the points 3.1, 4.2, or 5.3 can be rotated to coincide with point 2.0. The angle which the corrected trajectory makes with the reference trajectory immediately following a correction will always be $\delta\phi$.

The concept of "Dynamic Programming" and the "Principle of Optimality" (Ref. 1:15) are now utilized to determine the optimum sequence of corrections. As applied to this particular problem, the Principle of Optimality can be described in the following manner. Regardless of how the spacecraft arrives at any particular radial distance along the trajectory, from that point on the trajectory must be optimum, if the overall trajectory is to be optimum. The significance of this statement becomes more apparent when a concrete example is used. In Fig. 13 the first few possible correction radii, positions, and trajectories are shown. If in some manner the spacecraft arrives at point 3.0, due to error it will take Traj. #3, it must take the optimum path from 3.0 to orbit. There are two possibilities:

(1a) continuing on Traj. #3 to pericenter (3.2) and injecting into circular orbit of radius R_{o_3}; or,

(2a) correcting at R_2, and taking Traj. #2 to pericenter (2.1)

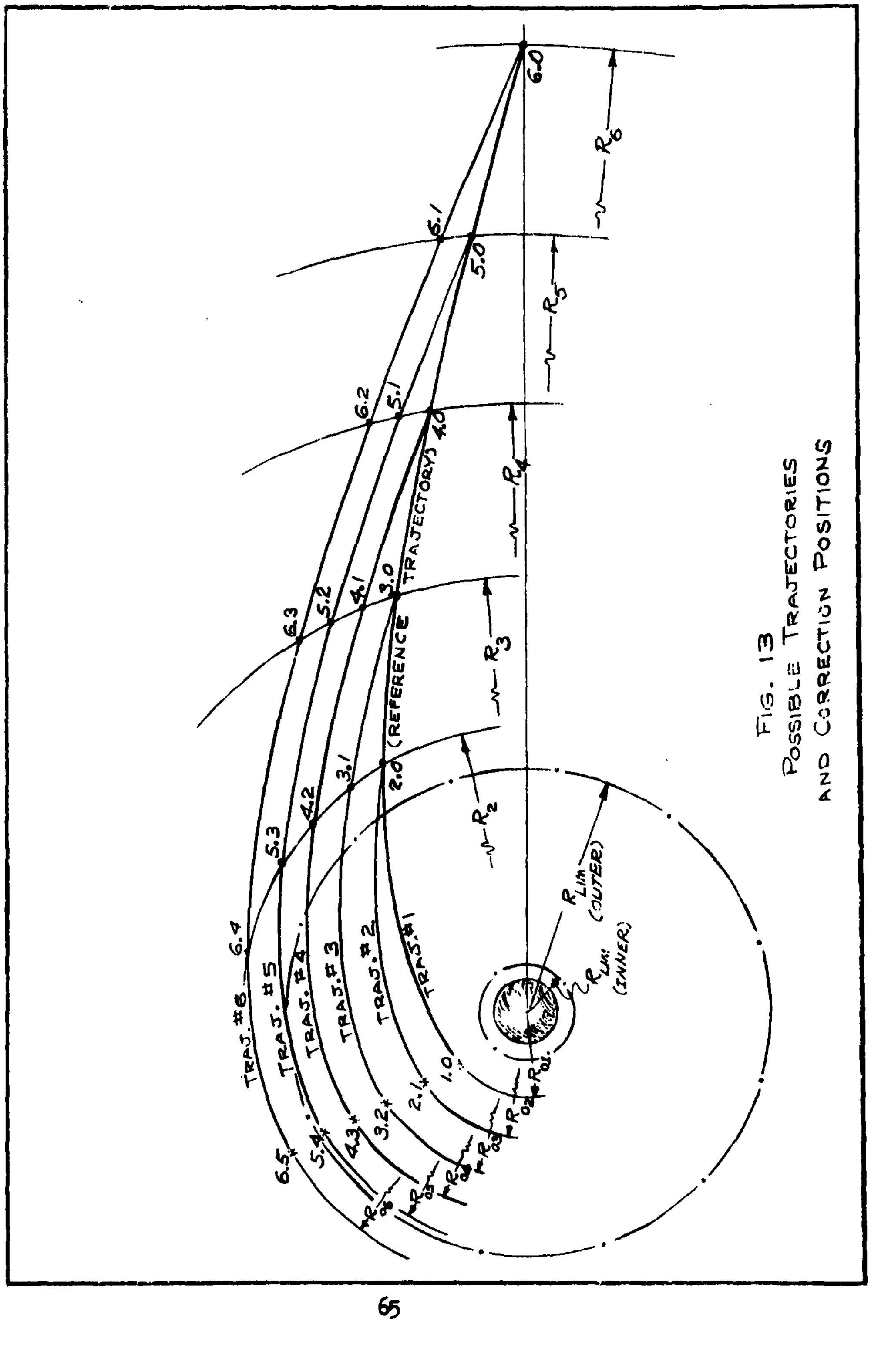


Fig. 13
Possible Trajectories
and Correction Positions

and injecting into an orbit of R_{o2}.

For the sake of example, consider the case where the sum of the two impulses of case (2) is less than the single orbital-injection impulse for case (1). Now consider the next point out on the reference trajectory; from the point 4.0 the optimum would be chosen from three possible paths:

(1b) continuing without a correction to pericenter and injecting into orbit (4.1 $\rightarrow$ 4.2),

(2b) correcting at R_3 (to Traj. #3), and continuing to pericenter (4.1 $\rightarrow$ 3.0 $\rightarrow$ 3.2), or

(3b) correcting at R_3 and at R_2 and continuing to pericenter on Traj. #2 (4.1 $\rightarrow$ 3.0 $\rightarrow$ 3.1 $\rightarrow$ 2.0 $\rightarrow$ 2.1).

But both of the latter two paths go through point 3.0 and the optimum from point 3.0 has already been found as case (2a). Therefore, case (2b) need not be considered at all since it imbodies case (1a) which is known not to be optimum. The optimum for a trajectory starting at 4.0 can be determined as either case (1b) or (3b). This type selection process is the essence of dynamic programming.

In actual application, the calculations are started at the point 2.0 and the trajectory origin is then moved outward to 3.0, 4.0, etc.; but, only one-step corrections are considered on the first phase of the calculations. In the example of Fig. 13, only the Trajectories numbered 1 to 5 would be acceptable as one-stage trajectories, since Traj. #6 lies outside the allowable range. The program would consider the trajectories up to #6, but when it found #6 unacceptable it would

discard it and start the next phase of the calculations.

Next, a similar process would be used for two-stage corrections. However, this time the results of the previous phase are used. The starting point this time will be point 3.0 (since the only trajectory allowed from point 2.0 is a one-stage trajectory). The only allowed path will be 3.0 → 3.1 → 2.0 → 2.1, for which the impulse can be obtained by adding the impulse correction at R_2 to the single-stage impulse which was determined for point 2.0 in the last phase of calculations. The origin of the trajectory is moved to point 4.0, and the optimum two-stage trajectory is selected from two possibilities:

(1c) 4.0 → 4.1 → 3.0, and

(2c) 4.0 → 4.2 → 2.0

The impulse sums for these paths may be determined by adding the one-stage impulses for trajectories from points 3.0 and 2.0 to the corresponding impulses necessary to correct from Traj. #4 to the reference trajectory at those points. The minimum sum is stored as the optimum two-stage impulse for origin 4.0. Along with this is stored the optimal policy: each correction radius for the optimum path.

The following notation is assumed for brevity:

n --the number of corrections in the current phase of calculations,

$F_1(i)$ --the optimum impulse sum for an n-stage correction path originating at R_i,

$F_2(i)$ --the optimum impulse sum for an (n-1)-stage correction path originating at R_i,

$\Delta V(j)$—the correction necessary at R_j on Traj. # i, to attain the reference trajectory.

Using this notation, the optimum for trajectories from 4.0, described above, is

$$F_1(4) = \text{MIN} \begin{cases} F_2(2) + \Delta V(2) \\ \qquad \text{for path } 4.0 \rightarrow 4.2 \rightarrow 2.0 \rightarrow 2.1 \\ \\ F_2(3) + \Delta V(3) \\ \qquad \text{for path } 4.0 \rightarrow 4.1 \rightarrow 3.0 \rightarrow 3.2 \end{cases} \tag{144}$$

and the optimum for trajectories originating at 5.0 is

$$F_1(5) = \text{MIN} \begin{cases} F_2(2) + \Delta V(2) \\ F_2(3) + \Delta V(3) \\ F_2(4) + \Delta V(4) \end{cases} \tag{145}$$

In general then, for a two-stage correction process

$$\underset{[n+1 \leq i \leq i_L]}{F_1(i) = \text{MIN}} \begin{cases} F_2(n) + \Delta V(n) \\ F_2(n+1) + \Delta V(n+1) \\ \vdots \\ F_2(i_K - 1) + \Delta V(i_K - 1) \\ F_2(i_K) + \Delta V(i_K) \end{cases} \tag{146}$$

where i_K is the largest i for which a one-stage correction is acceptable; in the foregoing example, $i_K = 5$.

And for phases of calculations with n-greater-than-two stages, the following general expression holds:

$$\underset{[n+1 \leq i \leq i_L]}{F_1(i)} = \mathrm{MIN} \begin{cases} F_2(n) + \Delta V(n) \\ F_2(n+1) + \Delta V(n+1) \\ \vdots \\ F_2(i_L - 1) + \Delta V(i_L - 1) \end{cases} \qquad (147)$$

where i_L is the largest possible correction radius (the radius of the sphere of influence).

Storage of the optimal policy for each i is accomplished by transfering the policy corresponding to F_2 of the optimal case and including the R of the optimal ΔV. If the optimum case were that of $(n+k)$, the optimal policy would be that of $F_2(n+k)$, plus the radius R_{n+k}.

The last computation step of any phase will be for $F_1(i_L)$, which is the impulse sum for the optimum trajectory starting at the sphere of influence and containing n subsequent corrections. (If the correction at the sphere of influence is included, the total number of corrections will be $n+1$.) This value, along with its optimal policy, is written out since it is the desired result. The program, therefore, will write out the optimal decision for each of n phases of computations. The output values can be compared to determine the most desirable number of corrections.

After each phase of the calculations is completed the (n-1)-stage tables are no longer needed. Therefore, they are replaced by the n-stage

optimal table in preparation for the computation of the $(n+1)$-stage table (i.e. $F_1 \rightarrow F_2$).

The memory storage requirements for the optimal tables limit the number of correction radii that can be considered. For each correction radius, the computer must allow ten storage positions for the optimal-policy radii (if ten is the maximum number of corrections allowed for the sequence) plus one position for the impulse sum. But, this is only for one table; since both the F_1 and the F_2 tables must be stored, each radius required 22 storage positions for the optimal tables alone. In addition to this, each radius will have its table of parameters, which requires five positions. Therefore, the storage tables for 1000 correction radii would require 27,000 positions, and this does not allow for what the remainder of the program will require. Because of the storage requirements and to decrease the running time, this program was run with 100 correction stations.

The actual calculations in the program are divided into two sections: first, for $n=1$, and secondly, for n=2-or-more. The $n=1$ calculations are in turn split, since inner and outer analyses required some slightly different calculations. The calculations for $n=1$ are listed below and should be easy to follow from the previous discussions.

$$e = \sqrt{\frac{H^2}{A_R} + 1} \tag{148}$$

$$R_o = A(e-1) \tag{149}$$

$$V_c = \sqrt{\frac{1}{R_o}} \tag{150}$$

$$V_o = \sqrt{\frac{1}{A_R} + \frac{2}{R}} \tag{151}$$

$$F_2 = V_o - V_c \tag{152}$$

The calculations for n=2-or-more have also been discussed previously; they are

$$\phi_j = \arcsin\left(\frac{H}{R_L V_L}\right) \tag{153}$$

Note: $V_j = V_{R_j}$, since $A_R = A_j$ (see pg. 74) (154)

$$\Delta\phi = \phi_L - \phi_R \tag{155}$$

$$V_{CR} = V_{R_j} \sin \Delta\phi \tag{156}$$

$$V_{LG} = V_{R_j} \cos \Delta\phi \tag{157}$$

$$\Delta V_{LG} = V_{R_j} - V_{LG} \tag{158}$$

$$\theta = \arctan\left(\frac{V_{CR}}{\Delta V_{LG}}\right) \tag{159}$$

$$\Delta V = \left| \frac{V_{CR}}{\sin\theta} \right| \tag{160}$$

$$F_i = \Delta V + F_2(j) \tag{161}$$

$$F_1(i) = \mathrm{MIN}\ [F_i] \tag{162}$$

The final impulse sum must include the initial correction at the sphere of influence, F_c .

$$F_{OPT} = F_1(i_L) + F_c \tag{163}$$

This sum is normalized by ΔV^* for output.

The data which are written out by this subroutine are possible one-stage correction policies and the optimum policies for all n stages.

Subroutine RMATX. The subroutine RMATX generates the correction radius grid and also the reference trajectory parameters for each grid point. The flow diagram for this sub-program is on pg 73. The input arguments from Subroutine OPTSEQ to the Subroutine RMATX are i_L, R_{IN}, R_R, H_R, $1/A_R$, and $\delta\phi$. (R_R here is equivalent to R_{OR}).

The correction-radius grid is not composed of equally spaced radii, since previous programs indicated that few corrections are desirable during the first half of the incoming trajectory and most of them are likely to be made during the last part of the trajectory. Therefore a geometrical progression of radii is used, so that the relationship between consecutive radii,

$$\frac{R_i}{R_{i-1}} = RM \quad , \tag{164}$$

is computed from the equation

$$RM = \left(\frac{R_{IN}}{R_R}\right)^{1/(i_L-1)} \quad , \tag{165}$$

since there are (i_L-1) intervals between the i_L radii. Since R_1 is reserved as the orbital radius, the radius grid starts with $R_R = R_2$. The actual calculations are quite familiar by now.

$$PE2_i = \frac{2}{R_i} \tag{166}$$

$$V_{R_i} = \sqrt{\frac{1}{A_R} + PE2_i} \tag{167}$$

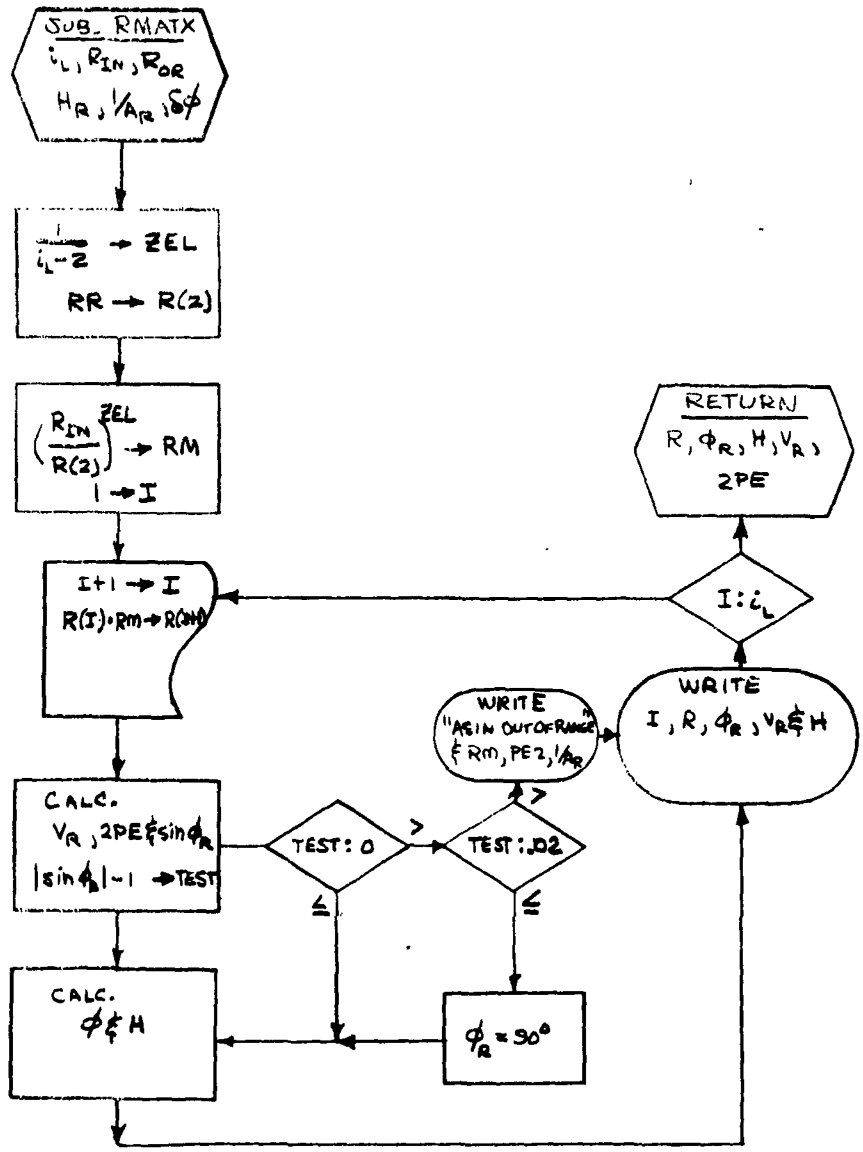


FIG. 14
SUBROUTINE RMATX
FLOW CHART

$$\phi_R = \arcsin\left(\frac{H}{R_i V_{R_i}}\right) \tag{168}$$

Since it is assumed that only the path angle is in error,

$$V = V_R \tag{169}$$

$$\phi = \phi_R + \delta\phi \tag{170}$$

$$A = A_R \text{, and} \tag{171}$$

$$\frac{H}{H_R} = \frac{\sin\phi}{\sin\phi_R} \tag{172}$$

The program contains a test for sines greater than one because slightly greater values were found for the pericenter position, due to slight errors or inaccurracies in rounding off in calculations.

The output to OPTSEQ from RMATX is the grid of parameters ϕ_R, H, V_R, and PE2, for each R; while the written output consists of each R with its corresponding ϕ_R, V_R, and H.

VI. Linear Perturbation Analysis of Error Effects

Purpose

This analysis is an approach to the determination of the effect that small errors have upon the various trajectory parameters. This investigation contains some features which are similar to those used by Dr. Traenkle in his analysis. The same sinusoidal error configuration is considered, but the approach and results of the analysis are different. The concern here is primarily with mathematical relationships, while Dr. Traenkle's analysis is based somewhat on geometrical considerations.

In addition to providing a comparison or verification of what has been previously done, this study will ultimately provide critera for determining the optimum direction of corrections, not only for minimizing the error in orbital radius, but also for error in impulse required at the orbit.

General Analysis

In general, it is assumed that there is no error in the position of the spacecraft, and that the only errors involved are in the velocity vector. The errors are defined as δV, the error in the velocity magnitude, and $\delta\phi$, the error in path angle. These errors are assumed to be small enough that a linear perturbation analysis is valid.

The velocity vector perturbations include corresponding error perturbations in the parameters of the trajectory. The velocity magni-

tude at any point on the resulting trajectory will be $V = V_R + \delta V$, where V_R is the reference or error-free trajectory. Similarly, $\phi = \phi_R + \delta\phi$ and the other parameters of the trajectory will be defined in the same manner, i.e. $A = A_R + \delta A$.

The quantities R, V_R, and ϕ_R are given. From these A_R, H_R, and e_R can be calculated.

$$A_R = \frac{1}{V_R^2 - V_{ES}^2} = \frac{1}{V_R^2 - \frac{2}{R}} \tag{178}$$

$$H_R = R V_R \sin\phi_R \tag{179}$$

$$e_R^2 = \frac{H_R^2}{A_R} + 1 \tag{180}$$

The perturbation quantities are found from these equations.

$$\delta A = -\frac{2V_R\,\delta V}{\left(V_R^2 - \frac{2}{R}\right)} = -2V_R A_R^2\,\delta V\,, \quad \text{or} \tag{181}$$

$$\frac{\delta A}{A_R} = -2V_R A_R\,\delta V\,. \tag{182}$$

$$\delta H = R V_R \cos\phi_R\,\delta\phi + R\,\delta V \sin\phi_R \tag{183}$$

$$= H_R\left(\cot\phi_R\,\delta\phi + \frac{\delta V}{V_R}\right), \quad \text{or} \tag{183a}$$

$$\frac{\delta H}{H_R} = \cot\phi_R\,\delta\phi + \frac{\delta V}{V_R}\,. \tag{184}$$

$$2e_R\,\delta e = \frac{2H_R\,\delta H}{A_R} - H_R\frac{\delta A}{A_R^2} = \frac{2H_R^2}{A_R}\left(\frac{\delta H}{H_R} - \frac{\delta A}{2A_R}\right), \tag{185}$$

$$\delta e = \frac{H_R^2}{e_R A_R}\left(\cot\phi_R\,\delta\phi + \frac{\delta V}{V_R} + V_R A_R\,\delta V\right) \tag{186}$$

$$\delta e = \frac{e_R - 1}{e_R}\left[\cot\phi_R\,\delta\phi + \frac{\delta V}{V_R}\left(1 + A_R V_R^2\right)\right] \tag{186a}$$

Since

$$\frac{H_R^2}{A_R} = e_R^2 - 1 \tag{187}$$

The reference orbital radius is $R_{oR} = A_R(e_R - 1)$; therefore, the perturbation δR_o is calculated as follows:

$$\delta R_o = \delta A(e_R - 1) + A_R\,\delta e \quad , \tag{188}$$

and when the values of $\delta A/A_R$ and δe from above are substituted the equation becomes

$$\delta R_o = -2V_R A_R^2\,\delta V(e_R - 1) + A_R\left(\frac{e_R^2 - 1}{e_R}\right)\left[\cot\phi_R\,\delta\phi + \frac{\delta V}{V_R}(1 + A_R V_R^2)\right] \tag{189}$$

$$= A(e_R - 1)\left\{\frac{e_R + 1}{e_R}\left[\cot\phi_R\,\delta\phi + \frac{\delta V}{V_R}(1 + A_R V_R^2)\right] - 2A_R V_R^2\,\frac{\delta V}{V_R}\right\} \quad , \tag{189a}$$

or

$$\frac{\delta R_o}{R_{oR}} = \frac{e_R + 1}{e_R}\left\{\cot\phi_R\,\delta\phi + \frac{\delta V}{V_R}\left[1 - A_R V_R^2\left(\frac{2e_R}{e_R + 1} - 1\right)\right]\right\} \tag{190}$$

$$= \frac{e_R + 1}{e_R}\left\{\cot\phi_R\,\delta\phi + \frac{\delta V}{V_R}\left[1 - A_R V_R^2\left(\frac{e_R - 1}{e_R + 1}\right)\right]\right\} \quad , \tag{190a}$$

but,

$$V_{oR}^2 = \frac{1}{A_R} + \frac{2}{R_{oR}} = \frac{1}{A_R} + \frac{2}{A_R(e_R - 1)} = \frac{e_R + 1}{A_R(e_R - 1)} \quad , \tag{191}$$

so

$$\frac{\delta R_o}{R_{oR}} = \frac{e_R + 1}{e_R}\left[\cot\phi_R\,\delta\phi + \frac{\delta V}{V_R}\left(1 - \frac{V_R^2}{V_{oR}^2}\right)\right] \quad . \tag{192}$$

Since the square of the velocity at pericenter of the trajectory is

$$V_{oR}^2 = \frac{e_R + 1}{A_R(e_R - 1)} = \frac{e_R + 1}{R_{oR}} \tag{193}$$

the perturbation in V_{oR} can be found as follows:

$$2V_{oR}\,\delta V_o = \frac{R_{oR}\,\delta e - (e_R + 1)\,\delta R_o}{R_{oR}^2} = \frac{\delta e}{R_{oR}} - \frac{e_R + 1}{R_{oR}}\cdot\frac{\delta R_o}{R_{oR}} \quad , \tag{194}$$

or $$\frac{\delta V_o}{V_{oR}} = \frac{\delta e}{2V_{oR}^2 R_{oR}} - \frac{\delta R_o}{2R_{oR}} \cdot \frac{e_R+1}{V_{oR}^2 R_{oR}} \tag{195}$$

but

$$V_{oR}^2 R_{oR} = (e_R+1) \quad . \tag{196}$$

Therefore,

$$\frac{\delta V_o}{V_{oR}} = \frac{\delta e}{2(e_R+1)} - \frac{\delta R_o}{2R_{oR}} \tag{197}$$

When Eqs. (186a) and (190a) are substituted into Eq. (197), the equation becomes

$$\frac{\delta V_o}{V_{oR}} = \frac{e_R^2-1}{2(e_R+1)e_R}\left[\cot\phi_R\,\delta\phi + \frac{\delta V}{V_R}\left(1+A_R V_R^2\right)\right] - \frac{e_R+1}{2e_R}\left[\cot\phi_R\,\delta\phi + \frac{\delta V}{V_R}\left(1-\frac{V_R^2}{V_{oR}^2}\right)\right] \tag{198}$$

$$= \frac{1}{2e_R}\left\{-2\cot\phi_R\,\delta\phi + \frac{\delta V}{V_R}\left[-1+(e_R-1)A_R V_R^2 + (e_R+1)\frac{V_R^2 A_R(e_R-1)}{(e_R+1)}\right]\right\} \tag{198a}$$

$$= \frac{1}{e_R}\left\{\frac{\delta V}{V_R}\left[(e_R-1)A_R V_R^2 - 1\right] - \cot\phi_R\,\delta\phi\right\} \tag{198b}$$

or $$\frac{\delta V_o}{V_{oR}} = \frac{1}{e_R}\left\{\frac{\delta V}{V_R}\left[R_{oR}V_R^2-1\right] - \cot\phi_R\,\delta\phi\right\} \quad . \tag{199}$$

The impulse necessary to inject into a curcular orbit at the pericenter of the reference trajectory is $\Delta V_{oR} = V_{oR} - V_{cR} = V_{oR} - 1/R_{oR}$, and the perturbation is

$$\delta\Delta V_o = \delta V_o + \frac{\delta R_o}{R_{oR}^2} \quad , \tag{200}$$

and

$$\frac{\delta\Delta V_o}{V_{oR}} = \frac{\delta V_o}{V_{oR}} + \frac{1}{V_{oR}R_{oR}}\cdot\frac{\delta R_o}{R_{oR}} = \frac{\delta V_o}{V_{oR}} + \frac{1}{H_R}\cdot\frac{\delta R_o}{R_{oR}} \quad . \tag{201}$$

After substitution of Eqs. (190a) and (199) involving the perturbation δV_o and δR_o, the following expressions are obtained:

$$\frac{\delta \Delta V_{oR}}{V_{oR}} = \frac{1}{e_R}\left[\frac{\delta V}{V_R}(R_{oR}V_R^2 - 1) - \cot\phi_R\,\delta\phi\right] + \frac{e_R+1}{e_R H_R}\left[\cot\phi_R\,\delta\phi + \frac{\delta V}{V_R}\left(1-\frac{V_R^2}{V_{oR}^2}\right)\right] \tag{202}$$

$$= \frac{1}{e_R}\left\{\left(\frac{e_R+1}{H_R}-1\right)\cot\phi_R\,\delta\phi + \frac{\delta V}{V_R}\left[R_{oR}V_R^2 - 1 + \frac{e_R+1}{H_R}\left(1-\frac{V_R^2}{V_{oR}^2}\right)\right]\right\} \tag{202a}$$

The quantity

$$\frac{e_R+1}{H_R} = \frac{H_R(e_R+1)}{H_R^2} = \frac{R_{oR}V_{oR}(e_R+1)}{A_R(e_R^2-1)} = V_{oR}\text{ , since} \tag{203}$$

$$H_R^2 = L_R = A_R(e_R^2-1) \quad\text{and}\quad R_{oR} = A_R(e_R-1) \tag{204}$$

Therefore,

$$\frac{\delta \Delta V_o}{V_{oR}} = \frac{1}{e_R}\left\{(V_{oR}-1)\cot\phi_R\,\delta\phi + \frac{\delta V}{V_R}\left[V_R^2\left(R_{oR}-\frac{1}{V_{oR}}\right)+V_{oR}-1\right]\right\} \tag{205}$$

and

$$\frac{\delta \Delta V_o}{V_{oR}(V_{oR}-1)} = \frac{1}{e_R}\left\{\frac{\delta V}{V_R}\left[\frac{V_R^2(H_R-1)}{V_{oR}(V_{oR}-1)}+1\right] + \cot\phi_R\,\delta\phi\right\} \tag{206}$$

The $\cot\phi_R$ can also be determined in terms of the other parameters of the trajectory.

$$\cot\phi_R = \sqrt{\sec^2\phi_R - 1} = -\sqrt{\frac{1}{\sin^2\phi_R}-1} \tag{207}$$

and

$$\sin\phi_R = \frac{H_R}{RV_R} = \frac{R_{oR}V_{oR}}{RV_R} \tag{208}$$

Therefore,

$$\cot\phi_R = -\sqrt{\left(\frac{RV_R}{H_R}\right)^2 - 1} \tag{209}$$

Sinusoidal Errors

If a sinusoidal possibility of error is assumed (Ref. 5:14), where $\delta\phi$ is a small angle as shown in Fig. 15, the following approximations can be made:

$$\cos\delta\phi \approx 1 \qquad (210)$$

$$\delta V \approx V_{ERR}\cos\theta \qquad (211)$$

$$\frac{\delta V}{V_R} \approx \frac{V_{ERR}}{V_R}\cos\theta \qquad (212)$$

$$\delta\phi \approx \sin\delta\phi$$

$$\approx \frac{V_{ERR}\sin\theta}{V_R + \delta V} \qquad (213)$$

$$\delta\phi \approx \frac{V_{ERR}}{V_R}\sin\theta \qquad (214)$$

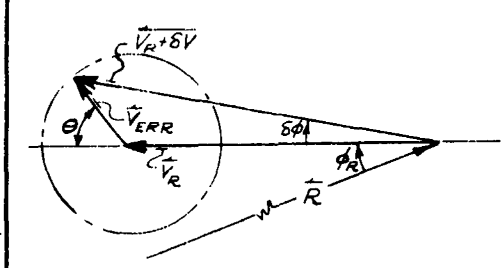


FIG. 15
SINUSOIDAL
ERROR CONFIGURATION

Extremes of the Perturbations

When the expressions for $\delta\phi$ and $\delta V/V_R$ in Eqs. (214) and (212) are inserted in Eqs. (184), (186a), (192), (199), and (206), the equations below result:

$$\frac{\delta H}{H_R} = \frac{V_{ERR}}{V_R}\left[\sin\theta\cot\phi_R + \cos\theta\right] \qquad (215)$$

$$\delta e = \frac{V_{ERR}}{V_R}\cdot\frac{e_R^2-1}{e_R}\left[\sin\theta\cot\phi_R + \cos\theta\left(1+A_R V_R^2\right)\right] \qquad (216)$$

$$\frac{\delta R_o}{R_{oR}} = \frac{V_{ERR}}{V_R}\cdot\frac{e_R+1}{e_R}\left[\sin\theta\cot\phi_R + \cos\theta\left(1-\frac{V_R^2}{V_{oR}^2}\right)\right] \qquad (217)$$

$$\frac{\delta V_o}{V_{oR}} = \frac{V_{ERR}}{V_R e_R}\left[-\sin\theta\cot\phi_R + \cos\theta\left(R_{oR}V_R^2-1\right)\right] \qquad (218)$$

$$\text{and } \frac{\delta V_o}{V_{OR}(V_{OR}-1)} = \frac{V_{ERR}}{V_R e_R}\left\{\sin\theta\cot\phi_R + \cos\theta\left[\frac{V_R^2(H_R-1)}{V_{OR}(V_{OR}-1)}+1\right]\right\} \tag{219}$$

The two perturbations of primary concern are δR_o and $\delta\Delta V_o$. To determine where their extremes lie with respect to the error angle, θ, Eqs. (219) and (217) are differentiated twice with respect to θ . Since the reference conditions do not vary with θ, the other factors on the left side of the equations will not affect the positions of the extremes. The first derivative is set to zero to determine the extreme condition, and the second derivative is evaluated at that point to determine the nature of the extreme.

First the error in ΔV_o is considered.

$$\frac{\partial}{\partial\theta}\left[\frac{\delta\Delta V_o}{V_{OR}(V_{OR}-1)}\right] = \frac{V_{ERR}}{V_R e_R}\left\{\cos\theta\cot\phi_R - \sin\theta\left[\frac{V_R^2(H_R-1)}{V_{OR}(V_{OR}-1)}+1\right]\right\} = 0 \tag{220}$$

and

$$\tan\theta_v = \frac{\cot\phi_R}{\frac{V_R^2}{V_{OR}}\cdot\frac{(H_R-1)}{(V_{OR}-1)}+1} = \frac{\left[\left(\frac{RV_R}{H_R}\right)^2-1\right]^{1/2}}{\frac{V_R^2}{V_{OR}^2}\cdot\frac{(H_R-1)}{\left(1-\frac{1}{V_{OR}}\right)}+1} \tag{221}$$

The quantities V_R, V_{ERR} , V_{OR}, and $\cot\phi_R$ are always taken positive by convention, and also $V_{OR} > 1 = V_{CO}$. If $A_R(e_R^2-1) > 1$, then $H_R = \left[A_R(e_R^2-1)\right]^{1/2} > 1$. For trajectories which do not intersect that planet's surface, $R_S = 1 < R_{OR} = A_R(e_R-1)$, and $A_R(e_R^2-1) > A_R(e_R-1)$, since $e_r > 1$ for hyperbolic paths. The second derivative is

$$\frac{\partial^2}{\partial\theta^2}\left[\frac{\delta\Delta V_o}{V_{OR}(V_{OR}-1)}\right] = \frac{V_{ERR}}{V_R e_R}\left\{-\sin\theta\cot\phi_R - \cos\theta\left[\frac{V_R^2(H_R-1)}{V_{OR}(V_{OR}-1)}+1\right]\right\} \tag{222}$$

In this case the tangent of Θ_V will be positive and Θ_V must be a 1^{st} or 3^{rd} quadrant angle. When Θ_V is in the first quadrant, the sine and cosine are both positive and the second derivative is always negative; the extreme is a maximum. On the other hand, when both the cosine and sine are negative for a third quadrant angle, the second derivative will always be positive and the perturbation is a minimum (or maximum negative value).

Cases of less concern could possible occur, if trajectories which intersect the planet surface are considered. When $H_R < 1$, so that $(H_R - 1) < 0$, and the tangent of Θ_V might be negative. In this case, would be a 2^{nd} or 4^{th} quadrant angle. If Θ_V is a second quadrant angle the cosine is negative and the sine is positive; therefore, both terms in the second derivative will be negative. This follows from the fact that $\cot\phi_R$ is positive and the quantity in the brackets of the second term is negative. A maximum perturbation must occur when Θ_V is a second quadrant angle. The opposite is true for a fourth quadrant angle--the second derivative is positive and the perturbation is a minimum.

When the same procedure is followed for the perturbation in R_o the following is obtained:

$$\frac{\partial}{\partial\Theta}\left(\frac{\delta R_o}{R_{oR}}\right) = \frac{V_{ERR}}{V_R} \cdot \frac{(e_R+1)}{e_R}\left[\cos\Theta\cot\phi_R - \sin\Theta\left(1 - \frac{V_R^2}{V_{OR}^2}\right)\right] = 0 \qquad (223)$$

$$\tan\Theta_R = \frac{\cot\phi_R}{\left(1 - \frac{V_R^2}{V_{oR}^2}\right)} = \frac{\left[\left(\frac{RV_R}{H_R}\right)^2 - 1\right]^{1/2}}{\left(1 - \frac{V_R^2}{V_{OR}^2}\right)} \; . \qquad (224)$$

and since $V_R < V_{OR}$, $(1 - V_R^2/V_{OR}^2) > 0$, the tangent of θ_R is always positive and θ_R is a 1st or 3rd quadrant angle. The second derivative is

$$\frac{\partial^2}{\partial\theta^2}\left(\frac{\delta R_o}{R_{OR}}\right) = \frac{V_{\delta RR}}{V_R} \cdot \frac{(e_R+1)}{e_R}\left[-\sin\theta\cot\phi_R - \cos\theta\left(1-\frac{V_R^2}{V_{OR}^2}\right)\right] \tag{225}$$

and will always have a negative value for first quadrant angles and positive for third quadrant angles. Therefore both θ_V and θ_R are 1st quadrant angles for conditions of maximum perturbations in ΔV_o and R_o , respectively.

Theoretical Optimum Reference Trajectory

If the theoretical optimum trajectory is assumed as the reference trajectory, the parameters become

$$R_{OR} = \frac{2}{V_{INF}^2} \tag{226}$$

$$\Delta V_{OR} = \Delta V^* = \frac{V_{INF}}{\sqrt{2}} \tag{227}$$

$$A_R = \frac{1}{V_{INF}^2} \tag{228}$$

$$V_{OR} = \sqrt{2}\ V_{INF} \tag{229}$$

$$e_R = 3 \tag{230}$$

and

$$H_R = \frac{2\sqrt{2}}{V_{INF}} \tag{231}$$

where V_{INF} is the velocity at infinity for the trajectory. Substitution of these expressions into Eqs. (221) and (224) yields

$$\theta_R = \arctan\left\{\frac{\left[\left(\frac{R V_R V_{INF}}{2\sqrt{2}}\right)^2 - 1\right]^{1/2}}{\left(1 - \frac{V_R^2}{2V_{INF}^2}\right)}\right\} \tag{232}$$

$$= \arctan\left\{\frac{\left[\frac{(R V_R V_{INF})^2}{8} - 1\right]^{1/2}}{\left[1 - \frac{1}{2}\left(\frac{V_R}{V_{INF}}\right)^2\right]}\right\} \tag{232a}$$

and

$$\theta_V = \arctan\left\{\frac{\left[\frac{(R V_R V_{INF})^2}{8} - 1\right]^{1/2}}{\left[\frac{V_R^2\left(\frac{2\sqrt{2}}{V_{INF}} - 1\right)}{2V_{INF}^2\left(1 - \frac{1}{V_{INF}\sqrt{2}}\right)} + 1\right]}\right\} \tag{233}$$

$$= \arctan\left\{\frac{\left[\frac{(R V_R V_{INF})^2}{8} - 1\right]^{1/2}}{\left[\frac{V_R^2}{V_{INF}^2}\cdot\frac{(2\sqrt{2} - V_{INF})}{(2V_{INF} - \sqrt{2})} + 1\right]}\right\} \tag{233a}$$

where θ_R and θ_V cause maximum perturbations if the angles are in the first quadrant, and minimum if they are in the third quadrant. If the direction of minimum perturbation is interpreted in a slightly different light, it is the best possible direction for a correction of a given magnitude, since it gives the maximum negative change in the trajectory parameter.

Programs 9 and 10. Two sets of numerical examples for θ_V and θ_R were computed for various conditions. Program 9 was used to compute those angles for various radial distances along the theoretical optimum trajectory, while Program 10 was used to compute the angles θ_V and θ_R for various path angles at the sphere of influence. The data used, in

both cases, was for the Mars H-trajectory, and the results are given in Chapter VII. Since the equations used in the programs have already been fully explained, the details of the program are not given here and the programs themselves are included in Appendix B.

VII. Discussion of Results

The results of both Part I and Part II of the thesis are described and compared in this chapter. The numerical values used for the initial velocities in all cases were obtained from page 7 of the appendix of Reference 2.

The first portion of this chapter discusses the results of four topics. The first is the sphere-of influence-entry error. The second topic is constant magnitude corrective impulse for a specified orbital radius. The third topic is the variable magnitude corrective impulse for a specified orbital radius, and the fourth topic is the outbound position and velocity errors at the sphere of influence due to an error velocity at injection.

The second portion of this chapter is concerned with the results from correction methods which allow a range of orbits. This section also contains comparisons of these results with those for fixed-orbit correction methods.

Trajectory Parameters for Part I

Tables IV through VII give the computed trajectory parameters for the 32 cases studied. The pericenter correction impulse, ΔV_p, is also listed in these tables as a percent of both the relative velocity at the sphere of influence and of the basic velocity sum.

Table IV

Venusian Reference Trajectory Constants

Trajectory Types	$\tilde{b}^R$	e^R	$\tilde{a}^R$	$\tilde{r}_p^R$	$\frac{\Delta V_p}{\Delta V_2}(100)$	$\frac{\Delta V_p}{V_s}(100)$
H-opt	20.7	3.00	7.31	1.46	68.44	35.76
H-close	4.16	1.15	7.31	1.10	116.5	60.84
A-opt	3.03	3.00	1.07	2.14	70.21	38.88
A-close	1.89	2.03	1.07	1.10	72.49	40.14
C-opt	.858	3.00	.303	.606	*	*
C-close	1.37	4.63	.303	1.10	71.92	48.94
D-opt	10.9	3.00	3.86	7.71	69.02	25.40
D-close	3.11	1.28	3.86	1.10	93.54	34.44

Table V

Martian Reference Trajectory Constants

Trajectory Types	$\tilde{b}^R$	e^R	$\tilde{a}^R$	$\tilde{r}_p^R$	$\frac{\Delta V_p}{\Delta V_2}(100)$	$\frac{\Delta V_p}{V_s}(100)$
H-opt	5.20	3.00	1.84	3.68	70.25	33.26
H-close	2.29	1.60	1.84	1.10	78.60	37.21
A-opt	.778	3.00	.275	.550	*	*
A-close	1.35	5.00	.275	1.10	72.36	31.03
B-opt	.355	3.00	.126	.251	*	*
B-close	1.22	9.77	.126	1.10	77.16	40.81
C-opt	.112	3.00	.039	.079	*	*
C-close	1.14	28.9	.039	1.10	84.45	53.22

* No runs were made since r_p^R was less than the surface radius

Table VI

Venus-Return Reference Trajectory Constants

Trajectory Types	$\tilde{b}^R$	e^R	$\tilde{a}^R$	$\tilde{r}_p^R$	$\frac{\Delta V_p}{\Delta V_i}(100)$	$\frac{\Delta V_p}{V_E}(100)$
H-opt	30.2	3.00	10.7	21.4	67.62	32.29
H-close	4.85	1.10	10.7	1.05	136.8	65.34
A-opt	5.56	3.00	1.97	3.93	70.10	31.29
A-close	2.29	1.53	1.97	1.05	30.31	35.84
C-opt	4.67	3.00	1.65	3.31	70.24	22.44
C-close	2.14	1.64	1.65	1.05	77.69	24.82
D-opt	4.25	3.00	1.50	3.00	70.32	44.43
D-close	2.06	1.70	1.50	1.05	76.42	48.29

Table VIII

Mars-Return Reference Trajectory Constants

Trajectory Types	$\tilde{b}^R$	e^R	$\tilde{a}^R$	$\tilde{r}_p^R$	$\frac{\Delta V_p}{\Delta V_i}(100)$	$\frac{\Delta V_p}{V_E}(100)$
H-opt	21.7	3.00	7.67	15.3	68.51	36.07
H-close	4.15	1.14	7.67	1.05	120.9	63.67
A-opt	2.15	3.00	.761	1.52	70.56	40.30
A-close	1.64	2.38	.761	1.05	71.25	40.69
B-opt	2.22	3.00	.784	1.57	70.47	33.19
B-close	1.66	2.34	.784	1.05	71.62	33.57
C-opt	1.60	3.00	.566	1.13	70.34	26.01
C-close	1.51	2.86	.566	1.05	70.37	26.02

Sphere of Influence Entry Error

The velocity corrections required at the sphere of influence to redirect the spacecraft's velocity vector to the reference velocity vector become increasingly larger as ϕ_∞ varies from 0° to $\pm 90^\circ$. The magnitude of correction at $+90^\circ$ is very large; the range is from 50.3% to 95.8% of the basic velocity sum. For -90°, the correction requires an impulse from 53.8% to 96.6% of the basic velocity sum. Even at $\phi_\infty = \pm 10^\circ$ (except for Venus H-opt.) the impulse required is from 4% to 12% of the basic velocity sum. The reason that Venus H-Optimum is excluded is that $\phi_\infty^R \approx +7^\circ$, so the error at $+10^\circ$ is small. In order to keep the percentage below two percent of the basic velocity sum, ϕ_∞ must be kept within 2° to 3° of the reference value. The largest allowable error for a 2% error is 3.1° in the case of the Venus trajectory, class D-Opt. The midcourse maneuvers, therefore, must guide the spacecraft accurately enough to have it enter the sphere of influence so that ϕ_∞ is within two or three degrees of ϕ_∞^R. In most cases, ϕ_∞^R is less than two degrees for Venusian trajectories, less than one degree for Martian trajectories, and less than one and a half degrees for return trajectories at Earth. Roughly then, the spacecraft's relative velocity vector must be directed at the target planet as it enters the sphere of influence. The required collision parameters for each trajectory are listed in Tables IV through VII.

Constant Magnitude Corrective Impulse

Listed in Table VIII are the corrective velocity impulse sums in

percent of the basic velocity sum for an error velocity of $\delta V^{E} = 0.00141$. In Appendix A, the values for the corrective velocity impulse sums for δV^{E} equal to 100%, 75%, 50%, 25%, and 10% of 0.00141 are listed for a unit error velocity. The results for δV^{E} equal to 100% of 0.00141 are all very encouraging since no percentage is above 5% and many are considerable less. Even more interesting are the magnitudes of the corrective velocity impulse sums for a unit error velocity. For the optimal trajectory cases, the sums are between 1.77 and 4.80. For the close trajectory cases, the sums are between 4.63 and 5.78. The larger spread for the optimal trajectory cases results from the differences in the optimal orbital radii. The larger the optimal orbital radius, the smaller are the corrective velocity sums. For any given orbital radius, the corrective velocity sums are very nearly equal for all three planets. The optimal correction sequence, therefore, seems to produce a relatively constant velocity sum depending mostly on the reference orbital radius chosen.

If the error velocity is less than 0.00141, the correction sequence does not change other than some of the later correction maneuvers are not needed. The ranges at which the corrections are made do not change much at all; only the number required becomes increasingly smaller as the error velocity decreases. This conclusion is drawn from the fact that the reduction number (erroneously labeled reduction factor in the computer output in Appendix A) for the five variation of δV^{E} for each initial condition are almost identical. For any proposed space mission, the chosen reference trajectory can be investigated and an optimal correction

Table VIII

Corrective Velocity Impulse Sum in Percent of Basic Velocity Sum

Venus

Class	n	% Vel. Sum
H-opt	1	1.40
H-close	10	4.14
	9	4.15
	8	4.20
	7	4.29
	6	4.48
A-opt	4	1.12
	3	1.15
	2	1.34
	1	2.70
A-close	9	1.63
	8	1.63
	7	1.66
	6	1.71
	5	1.80
C-close	8	1.00
	7	1.01
	6	1.02
	5	1.06
	4	1.15
D-opt	2	0.94
	1	1.07
D-close	10	2.11
	9	2.11
	8	2.13
	7	2.18
	6	2.26

Mars

Class	n	% Vel. Sum
H-opt	6	2.99
	5	3.01
	4	3.11
	3	3.44
	2	4.57
H-close	12	4.34
	11	4.35
	10	4.39
	9	4.46
	8	4.58
A-close	11	1.42
	10	1.42
	9	1.42
	8	1.44
	7	1.49
B-close	10	1.14
	9	1.14
	8	1.15
	7	1.17
	6	1.22
C-close	9	.712
	8	.713
	7	.720
	6	.740
	5	.779

(Table VIII cont.)

Venus-Return

Class	n	% Vel. Sum
H-opt	1	1.49
H-close	12	4.55
	11	4.56
	10	4.60
	9	4.67
	8	4.79
A-opt	3	1.02
	2	1.11
	1	1.87
A-close	11	1.83
	10	1.84
	9	1.86
	8	1.90
	7	1.96
C-opt	4	.695
	3	.705
	2	.790
	1	1.44
C-close	11	1.20
	10	1.20
	9	1.21
	8	1.24
	7	1.28
D-opt	4	1.34
	3	1.37
	2	1.56
	1	2.98
D-close	11	2.25
	10	2.26
	9	2.28
	8	2.32
	7	2.40

Mars-Return

Class	n	% Vel. Sum
H-opt	2	1.60
	1	1.71
H-close	12	4.29
	11	4.30
	10	4.33
	9	4.39
	8	4.50
A-opt	6	1.06
	5	1.07
	4	1.12
	3	1.24
	2	1.67
A-close	11	1.42
	10	1.42
	9	1.43
	8	1.45
	7	1.49
B-opt	6	.880
	5	.886
	4	.917
	3	1.01
	2	1.35
B-close	11	1.19
	10	1.19
	9	1.20
	8	1.21
	7	1.25
C-opt	8	.705
	7	.711
	6	.728
	5	.766
	4	.846
C-close	10	.782
	9	.784
	8	.734
	7	.815
	6	.854

sequence determined. If the errors in the spacecraft's systems should be less than the anticipated values, the same sequence would be used, but some of the later corrections would be eliminated. Once a correction is made accurately enough to direct the spacecraft to within tolerable limits, no more corrections need be made and the sequence would still have been the optimal one. The optimum reduction number is usually very close to 0.6.

A check was made on the time interval between correction positions to determine if there would be sufficient time to make necessary measurements. In the cases where ten or more corrections had to be made, the last time interval is less than ten minutes. If this time difference is minimum, then a correction sequence which is less than optimum would have to be used. The optimum, however, is quite flat and only a very small increase would be required to reduce the number of corrections to 75% of optimum. If the number of corrections for Mars, class-A-close, is reduced from 11 to 8, the change in percent of the basic velocity sum is 0.02.

A small error in the computation of the times was introduced because the Q vs range plots were assumed to be straight lines which passed through the abscissa at $r = r_p^k$. In the case illustrated in Fig. 16 this assumption is reasonably accurate, but the case illustrated in Fig. 17 is perceptably in error. The curve should pass through 14.6 on the abscissa, but it actually passes through 8. The case in Fig.17 represents the worst deviation of all the solutions. The case in Fig. 16, however, is much more representative of the majority of

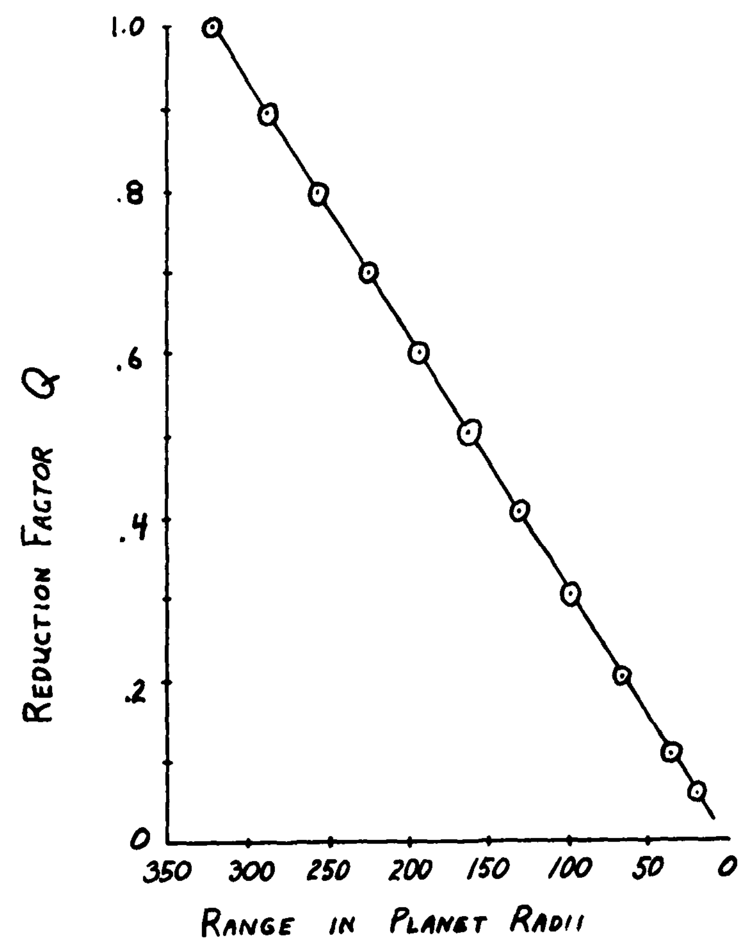


Fig. 16
Q vs R for Mars-H-Opt

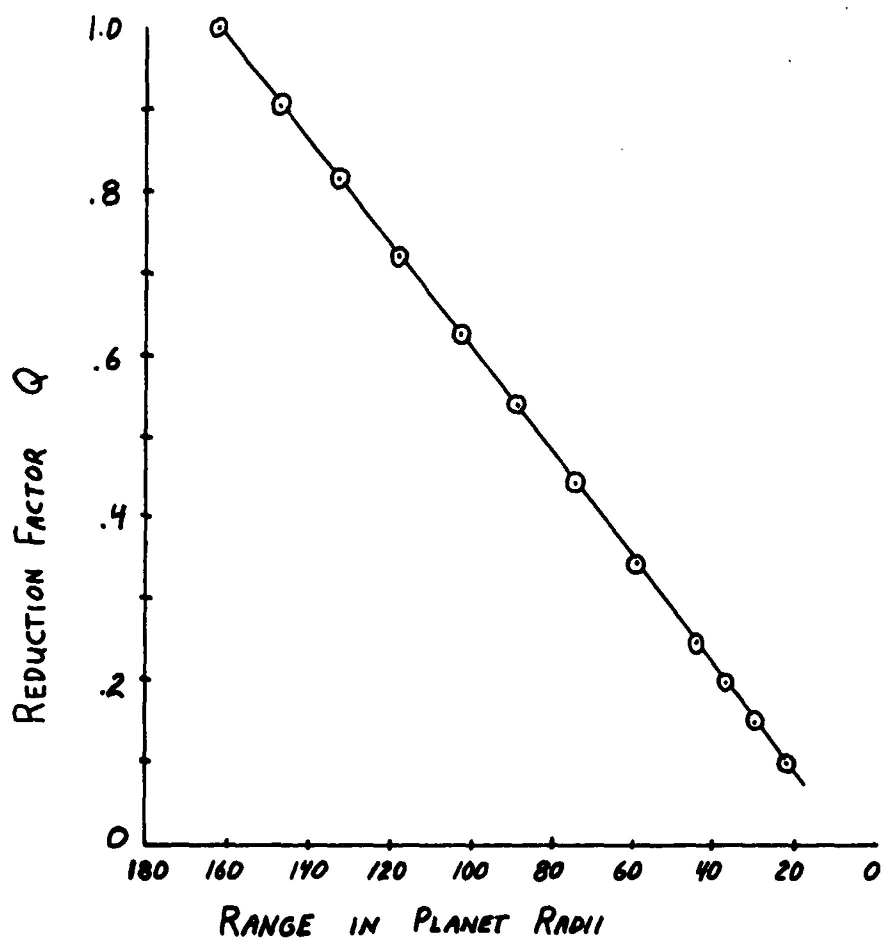


Fig. 17
Q vs R for Venus-H-Opt

solutions.

Variable Magnitude Corrective Impulse

When K is varied as well as n, the optimal sequence does not change appreciably. In fact, in 4 out of the 6 cases the results are identical. The most probable reason that all the cases do not exactly agree is that the limited number of correction positions do not allow the optimum case to be found. Five-hundred equally spaced range positions were used, but in order to more closely approach the true optimum a thousand, or more would be needed. In the case of Mars, Class-H-close, an increment as small as 0.457 planet radius is needed, but with 500 correction positions the increment is 0.621 planet radius. Every indication is that a fixed K or constant magnitude corrective impulse sequence is truly the optimum. All the conclusions drawn from that analysis, therefore, are general. Also, the computer time required for the fixed K solutions is very much less than for the variable K solutions. A large savings in computer expenses is obtained through the use of the constant K technique.

Outbound Velocity and Position Error

The resultant error velocity at the sphere of influence plots as an ellipse. (Fig. 18 and 19). The error velocities are quite small and would require a corrective impulse which is equal to or less than the corrective velocity sum of the optimal corrective sequence of the inbound leg. The position error is usually one or two planet radii; the largest error is less than eight planet radii. Since the sphere of in-

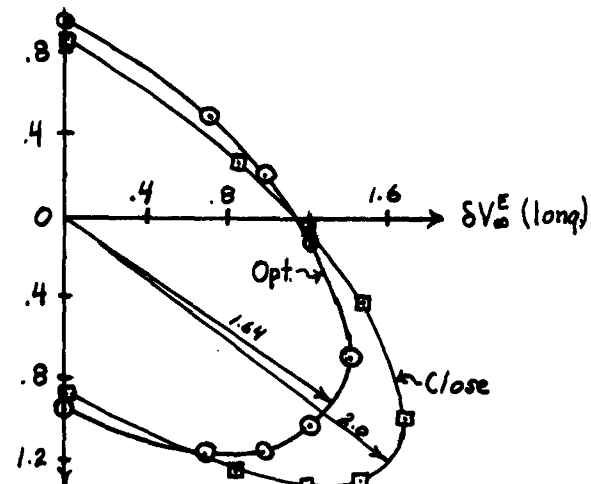


FIG. 18

VENUS-RETURN CLASS-A

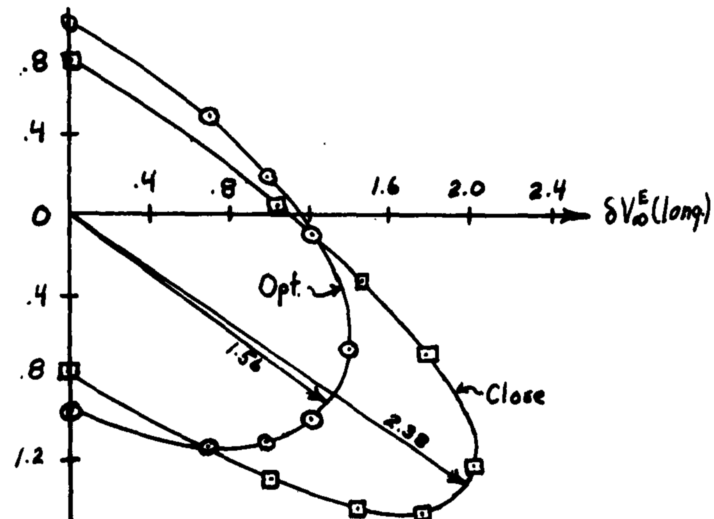


FIG. 19

MARS-RETURN CLASS-H

fluence is the cross-over point between the outbound leg in the local gravity field and the midcourse leg in heliocentric space, these errors should be judged with respect to the latter region. A few planet radii hardly measureable in heliocentric space and this error may be ignored. Whether to correct the velocity error at this point must be based on a midcourse evaluation. The resultant error velocity is even a smaller percentage with respect to the heliocentric referenced velocity since V_1 , or V_2 is always greater than ΔV_1 or ΔV_2. In an event, the errors are quite small and only a modest corrective velocity impulse will be required to correct the velocity error if it is done at the sphere of influence.

<u>One-Stage Correction with Orbital Range</u>

The results of Program 7 are given on pages 100 to 106, and include seven sets of data: five sets are for the Mars H-Trajectory, which is used as a primary reference for comparisons in this section, one for the Mars A-Trajectory, and one for the Venus H-Trajectory. The Mars-H data sets, except for set (4), all allow an orbital-range of $1.1 \leq R_0 \leq 6.1$; they are described as follows:

(1) Initial path angles from -90° to 90° in increments of ten degrees, are used to examine the effects of large error angles;

(2) More realistic errors are examined with path angles from -10° to 10°, in increments of one degree;

(3) Path angles from 0° to 2°, in increments of one-tenth of a degree, show the effects of very small errors;

(4) a fixed orbital radius, $R_o = R_o^*$, is used as a basis for comparison of fixed vs. varying-orbit analyses; and the path angles are the same as the following set;

(5) Path angles varying up to 10^o on either side of the theoretical optimum reference trajectory are considered in one degree steps for both fixed and variable orbits.

Both the Mars-A and the Venus-H data contain one set of angles varying from -90^o to 90^o increments of one degree. Each number in the data is followed by "E" and two digits which indicate the proper position of the decimal, i.e. $0.1000E\text{-}02 = 0.1000(10)^{-2}$.

The three trajectory classes discussed here were selected to serve as examples because they included theoretical optimum radii which lay within, inside of, and outside of the allowable radius range. In addition to these examples, five other classes of trajectories were analyzed by Program 7 and are on pages 274 through 284 of Appendix B. The other classes are the Mars B and C trajectories and the Venus D, A, and C trajectories. Other sets of data for the Mars H and A trajectories and for the Venus H trajectory are also included in Appendix B.

Comparison of One-Stage Correction Methods

As stated previously, when the initial-path-angle error is large, the magnitude of the impulse for correction to the theoretical optimum trajectory is very large. At least this is true when only the path angle is corrected and the magnitude of the velocity remains unchanged.

Now consider a correction where only the orbital radius remains

OPTIMUM 2-STAGE TRAJECTORY

MARS H-TRAJECTORY

RMIN = 0.1100E 01	RMAX= 0.6100E 01	RIN= 0.3260E 03	RE= 0.6370E 04	PCERR= 1.0000E-04	L= 19
ROIN = 0.1100E 01	FIIN=-0.9000E 02	VIN= 0.8900E-01	VE= 0.2980E 02	ODVI = 0.5555E 05	M= 10
DROIN= 0.5000E 00	DFI = 0.1000E 02	G = 0.1080E-00	GE= 0.3990E 06	ICI = 0	N= 10
RS = 0.5300E 00					

OPTRON = 0.36699537E 01   OPTDVE = 0.62581232E-01   OPTFI= 0.90712652E 00

OPTDV(KM/S)= 0.12390130E 05   OPTRO(KM)= 0.18649207E 01

FI INIT. DEGREES	ORB.RADIUS /RS	TOTAL DV /OPT.DV	DV AT ORB. /OPT.DV	DV AT RIN /OPT.DV	FI DEGREES	PSI DEGREES	V /VE
-0.9000E 02	0.5600E 01	0.1785E 01	0.3353E-00	0.1449E 01	0.7530E 01	0.8411E 02	0.9392E-02
-0.8000E 02	0.5600E 01	0.1759E 01	0.3354E-00	0.1424E 01	0.7517E 01	0.9394E 02	0.9408E-02
-0.7000E 02	0.5600E 01	0.1729E 01	0.3467E-00	0.1382E 01	0.5168E 01	0.1011E 03	0.1380E-01
-0.6000E 02	0.5600E 01	0.1681E 01	0.3731E-00	0.1308E 01	0.3503E 01	0.1069E 03	0.2081E-01
-0.5000E 02	0.5600E 01	0.1615E 01	0.4144E-00	0.1201E 01	0.2631E 01	0.1124E 03	0.2866E-01
-0.4000E 02	0.5600E 01	0.1531E 01	0.4704E-00	0.1060E 01	0.2130E 01	0.1180E 03	0.3702E-01
-0.3000E 02	0.5600E 01	0.1429E 01	0.5468E 00	0.8825E 00	0.1798E 01	0.1237E 03	0.4647E-01
-0.2000E 02	0.5600E 01	0.1311E 01	0.6481E 00	0.6631E 00	0.1569E 01	0.1295E 03	0.5724E-01
-1.0000E 01	0.5100E 01	0.1177E 01	0.7967E 00	0.3804E-00	0.1299E 01	0.1342E 03	0.7106E-01
0.8538E-06	0.3600E 01	0.1016E 01	0.9844E 00	0.3136E-01	0.9012E 00	0.1354E 03	0.8761E-01
0.1000E 02	0.5600E 01	0.1139E 01	0.8270E 00	0.3116E-00	0.1366E 01	-0.1354E 03	0.7379E-01
0.2000E 02	0.5600E 01	0.1272E 01	0.6757E 00	0.5965E 00	0.1526E 01	-0.1294E 03	0.5996E-01
0.3000E 02	0.5600E 01	0.1390E 01	0.5642E 00	0.8261E 00	0.1747E 01	-0.1237E 03	0.4843E-01
0.4000E 02	0.5600E 01	0.1492E 01	0.4817E-00	0.1010E 01	0.2064E 01	-0.1180E 03	0.3853E-01
0.5000E 02	0.5600E 01	0.1576E 01	0.4212E-00	0.1155E 01	0.2546E 01	-0.1123E 03	0.2978E-01
0.6000E 02	0.5600E 01	0.1642E 01	0.3773E-00	0.1265E 01	0.3368E 01	-0.1068E 03	0.2172E-01
0.7000E 02	0.5600E 01	0.1690E 01	0.3478E-00	0.1342E 01	0.5038E 01	-0.1012E 03	0.1417E-01
0.8000E 02	0.5600E 01	0.1720E 01	0.3354E-00	0.1384E 01	0.7517E 01	-0.9406E 02	0.9408E-02
0.9000E 02	0.5600E 01	0.1746E 01	0.3353E-00	0.1410E 01	0.7530E 01	-0.8394E 02	0.9392E-02

OPTIMUM 2-STAGE TRAJECTORY

```
MARS     H-TRAJECTORY
RMIN = 0.1100E 01    RMAX= 0.6100E 01    RIN= 0.3260E 03    RE= 0.6370E 04    PCERR= 1.0000E-04    L= 21
ROIN = 0.1100E 01    FIIN=-0.1000E 02    VIN= 0.8900E-01    VE= 0.2980E 02    ODVI = 0.5555E 05    M= 10
DROIN= 0.5000E 00    DFI = 0.1000E 01    G  = 0.1080E-00    GE= 0.3990E 06    ICI  =  0            N= 10
RS   = 0.5300E 00
OPTRON       = 0.36699537E 01            OPTDVE    = 0.62581232E-01              OPTFI= 0.90712652E 00
OPTDV(KM/S)= 0.12390130E 05              OPTRO(KM)= 0.18649207E 01
```

FI INIT. DEGREES	ORB.RADIUS /RS	TOTAL DV /OPT.DV	DV AT ORB. /OPT.DV	DV AT RIN /OPT.DV	FI DEGREES	PSI DEGREES	V /VE
-0.1000E 02	0.5100E 01	0.1177E 01	0.7967E 00	0.3804E-00	0.1299E 01	0.1342E 03	0.7106E-01
-0.9000E 01	0.5100E 01	0.1163E 01	0.8122E 00	0.3504E-00	0.1286E 01	0.1349E 03	0.7246E-01
-0.8000E 01	0.4600E 01	0.1147E 01	0.8350E 00	0.3125E-00	0.1175E 01	0.1347E 03	0.7441E-01
-0.7000E 01	0.4600E 01	0.1132E 01	0.8538E 00	0.2784E-00	0.1161E 01	0.1347E 03	0.7611E-01
-0.6000E 01	0.4100E 01	0.1117E 01	0.8792E 00	0.2374E-00	0.1052E 01	0.1337E 03	0.7826E-01
-0.5000E 01	0.4100E 01	0.1100E 01	0.8949E 00	0.2056E-00	0.1042E 01	0.1343E 03	0.7969E-01
-0.4000E 01	0.4100E 01	0.1084E 01	0.9113E 00	0.1729E-00	0.1032E 01	0.1349E 03	0.8116E-01
-0.3000E 01	0.3600E 01	0.1068E 01	0.9355E 00	0.1322E-00	0.9258E 00	0.1335E 03	0.8319E-01
-0.2000E 01	0.3600E 01	0.1051E 01	0.9511E 00	0.9942E-01	0.9175E 00	0.1342E 03	0.8462E-01
-1.0000E 00	0.3600E 01	0.1033E 01	0.9681E 00	0.6514E-01	0.9090E 00	0.1342E 03	0.8615E-01
0.3202E-06	0.3600E 01	0.1016E 01	0.9844E 00	0.3136E-01	0.9012E 00	0.1354E 03	0.8761E-01
0.1000E 01	0.4100E 01	0.1001E 01	0.9997E 00	0.1486E-02	0.9870E 00	-0.1664E 03	0.8891E-01
0.2000E 01	0.4100E 01	0.1018E 01	0.9809E 00	0.3679E-01	0.9955E 00	-0.1363E 03	0.8729E-01
0.3000E 01	0.4600E 01	0.1034E 01	0.9631E 00	0.7086E-01	0.1097E 01	-0.1371E 03	0.8565E-01
0.4000E 01	0.4600E 01	0.1050E 01	0.9440E 00	0.1059E-00	0.1106E 01	-0.1362E 03	0.8401E-01
0.5000E 01	0.5100E 01	0.1066E 01	0.9238E 00	0.1418E-00	0.1210E 01	-0.1373E 03	0.8216E-01
0.6000E 01	0.5100E 01	0.1081E 01	0.9058E 00	0.1750E-00	0.1220E 01	-0.1362E 03	0.8063E-01
0.7000E 01	0.5600E 01	0.1096E 01	0.8834E 00	0.2123E-00	0.1327E 01	-0.1372E 03	0.7861E-01
0.8000E 01	0.5600E 01	0.1110E 01	0.8637E 00	0.2464E-00	0.1340E 01	-0.1366E 03	0.7694E-01
0.9000E 01	0.5600E 01	0.1124E 01	0.8456E 00	0.2789E-00	0.1352E 01	-0.1359E 03	0.7539E-01
0.1000E 02	0.5600E 01	0.1139E 01	0.8270E 00	0.3116E-00	0.1366E 01	-0.1354E 03	0.7379E-01

OPTIMUM 2-STAGE TRAJECTORY

MARS H-TRAJECTORY

RMIN = 0.1100E 01	RMAX= 0.6100E 01	RIN= 0.3260E 03	RE= 0.6370E 04	PCERR= 1.0000E-04	L= 21
ROIN = 0.1100E 01	FIIN= 0.	VIN= 0.8900E-01	VE= 0.2980E 02	ODVI = 0.5555E 05	M= 10
DROIN= 0.5000E 00	DFI = 0.1000E-00	G = 0.1080E-00	GE= 0.3990E 06	ICI = 0	N= 10

RS = 0.5300E 00

OPTRON = 0.36699537E 01 OPTDVE = 0.62581232E-01 OPTFI= 0.90712652E 00

OPTDV(KM/S)= 0.12390130E 05 OPTRO(KM)= 0.18649207E 01

FI INIT. DEGREES	ORB.RADIUS /RS	TOTAL DV /OPT.DV	DV AT ORB. /OPT.DV	DV AT RIN /OPT.DV	FI DEGREES	PSI DEGREES	V /VE
0.	0.3600E 01	0.1016E 01	0.9844E 00	0.3136E-01	0.9012E 00	0.1354E 03	0.8761E-01
0.1000E-00	0.3600E 01	0.1014E 01	0.9863E 00	0.2775E-01	0.9004E 00	0.1352E 03	0.8778E-01
0.2000E-00	0.3600E 01	0.1012E 01	0.9883E 00	0.2394E-01	0.8994E 00	0.1344E 03	0.8796E-01
0.3000E-00	0.3600E 01	0.1010E 01	0.9896E 00	0.2087E-01	0.8988E 00	0.1355E 03	0.8808E-01
0.4000E-00	0.3600E 01	0.1009E 01	0.9915E 00	0.1725E-01	0.8980E 00	0.1351E 03	0.8824E-01
0.5000E-00	0.3600E 01	0.1007E 01	0.9932E 00	0.1379E-01	0.8972E 00	0.1353E 03	0.8839E-01
0.6000E 00	0.3600E 01	0.1005E 01	0.9948E 00	0.1037E-01	0.8965E 00	0.1357E 03	0.8854E-01
0.7000E 00	0.3600E 01	0.1003E 01	0.9968E 00	0.6648E-02	0.8956E 00	0.1340E 03	0.8872E-01
0.8000E 00	0.3600E 01	0.1002E 01	0.9984E 00	0.3282E-02	0.8949E 00	0.1350E 03	0.8886E-01
0.9000E 00	0.3600E 01	0.1000E 01	0.9991E 00	0.1331E-02	0.8946E 00	-0.1733E 03	0.8892E-01
1.0000E 00	0.4100E 01	0.1001E 01	0.9997E 00	0.1486E-02	0.9870E 00	-0.1664E 03	0.8891E-01
0.1100E 01	0.4100E 01	0.1003E 01	0.9986E 00	0.4089E-02	0.9875E 00	-0.1359E 03	0.8881E-01
0.1200E 01	0.4100E 01	0.1004E 01	0.9966E 00	0.7713E-02	0.9883E 00	-0.1361E 03	0.8865E-01
0.1300E 01	0.4100E 01	0.1006E 01	0.9947E 00	0.1134E-01	0.9892E 00	-0.1361E 03	0.8848E-01
0.1400E 01	0.4100E 01	0.1008E 01	0.9927E 00	0.1499E-01	0.9901E 00	-0.1363E 03	0.8831E-01
0.1500E 01	0.4100E 01	0.1009E 01	0.9905E 00	0.1889E-01	0.9911E 00	-0.1370E 03	0.8812E-01
0.1600E 01	0.4100E 01	0.1011E 01	0.9891E 00	0.2192E-01	0.9917E 00	-0.1355E 03	0.8800E-01
0.1700E 01	0.4100E 01	0.1013E 01	0.9870E 00	0.2574E-01	0.9927E 00	-0.1360E 03	0.8781E-01
0.1800E 01	0.4100E 01	0.1014E 01	0.9850E 00	0.2936E-01	0.9936E 00	-0.1360E 03	0.8765E-01
0.1900E 01	0.4100E 01	0.1016E 01	0.9830E 00	0.3308E-01	0.9946E 00	-0.1362E 03	0.8747E-01
0.2000E 01	0.4100E 01	0.1018E 01	0.9809E 00	0.3679E-01	0.9955E 00	-0.1363E 03	0.8729E-01

OPTIMUM 2-STAGE TRAJECTORY

```
MARS    H-TRAJECTORY
RMIN = 0.3670E 01    RMAX= 0.3670E 01    RIN= 0.3260E 03     RE= 0.6370E 04    PCERR= 1.0000E-04    L= 21
ROIN = 0.3670E 01    FIIN=-0.9093E 01    VIN= 0.8900E-01     VE= 0.2980E 02    ODVI = 0.5555E 05    M=  1
DROIN= 0.            DFI = 0.1000E 01    G  = 0.1080E-00     GE= 0.3990E 06    ICI  =  0            N= 10
RS   = 0.5300E 00
OPTRON      = 0.36699537E 01             OPTDVE    = 0.62581232E-01            OPTFI= 0.90712652E 00
OPTDV(KM/S)= 0.12390130E 05              OPTRO(KM)= 0.18649207E 01
```

FI INIT. DEGREES	ORB.RADIUS /RS	TOTAL DV /OPT.DV	DV AT ORB. /OPT.DV	DV AT RIN /OPT.DV	FI DEGREES	PSI DEGREES	V /VE
-0.9093E 01	0.3670E 01	0.1168E 01	0.8446E 00	0.3235E-00	0.9967E 00	0.1306E 03	0.7471E-01
-0.8093E 01	0.3670E 01	0.1152E 01	0.8581E 00	0.2939E-00	0.9869E 00	0.1312E 03	0.7601E-01
-0.7093E 01	0.3670E 01	0.1136E 01	0.8719E 00	0.2639E-00	0.9773E 00	0.1318E 03	0.7732E-01
-0.6093E 01	0.3670E 01	0.1119E 01	0.8870E 00	0.2323E-00	0.9673E 00	0.1322E 03	0.7875E-01
-0.5093E 01	0.3670E 01	0.1103E 01	0.9038E 00	0.1990E-00	0.9569E 00	0.1321E 03	0.8031E-01
-0.4093E 01	0.3670E 01	0.1086E 01	0.9169E 00	0.1691E-00	0.9492E 00	0.1333E 03	0.8153E-01
-0.3093E 01	0.3670E 01	0.1069E 01	0.9330E 00	0.1361E-00	0.9401E 00	0.1337E 03	0.8300E-01
-0.2093E 01	0.3670E 01	0.1052E 01	0.9488E 00	0.1033E-00	0.9317E 00	0.1343E 03	0.8443E-01
-0.1093E 01	0.3670E 01	0.1035E 01	0.9652E 00	0.6967E-01	0.9234E 00	0.1350E 03	0.8591E-01
-0.9287E-01	0.3670E 01	0.1018E 01	0.9826E 00	0.3489E-01	0.9150E 00	0.1351E 03	0.8746E-01
0.9071E 00	0.3670E 01	0.1000E 01	0.9990E 00	0.1342E-02	0.9076E 00	-0.1795E 03	0.8892E-01
0.1907E 01	0.3670E 01	0.1017E 01	0.9823E 00	0.3494E-01	0.9152E 00	-0.1343E 03	0.8743E-01
0.2907E 01	0.3670E 01	0.1034E 01	0.9652E 00	0.6911E-01	0.9234E 00	-0.1337E 03	0.8591E-01
0.3907E 01	0.3670E 01	0.1051E 01	0.9481E 00	0.1031E-00	0.9321E 00	-0.1334E 03	0.8437E-01
0.4907E 01	0.3670E 01	0.1068E 01	0.9317E 00	0.1363E-00	0.9408E 00	-0.1329E 03	0.8288E-01
0.5907E 01	0.3670E 01	0.1085E 01	0.9159E 00	0.1687E-00	0.9497E 00	-0.1323E 03	0.8143E-01
0.6907E 01	0.3670E 01	0.1101E 01	0.9002E 00	0.2009E-00	0.9591E 00	-0.1319E 03	0.7997E-01
0.7907E 01	0.3670E 01	0.1117E 01	0.8850E 00	0.2323E-00	0.9686E 00	-0.1313E 03	0.7856E-01
0.8907E 01	0.3670E 01	0.1133E 01	0.8706E 00	0.2629E-00	0.9782E 00	-0.1308E 03	0.7720E-01
0.9907E 01	0.3670E 01	0.1149E 01	0.8561E 00	0.2933E-00	0.9883E 00	-0.1303E 03	0.7582E-01
0.1091E 02	0.3670E 01	0.1165E 01	0.8413E 00	0.3239E-00	0.9992E 00	-0.1299E 03	0.7439E-01

OPTIMUM 2-STAGE TRAJECTORY

MARS H-TRAJECTORY

RMIN = 0.1100E 01	RMAX= 0.6100E 01	RIN= 0.3260E 03	RE= 0.6370E 04	PCERR= 1.0000E-04	L= 21
ROIN = 0.1100E 01	FIIN=-0.9093E 01	VIN= 0.8900E-01	VE= 0.2980E 02	ODVI = 0.5555E 05	M= 10
DROIN= 0.5000E 00	DFI = 0.1000E 01	G = 0.1080E-00	GE= 0.3990E 06	ICI = 0	N= 10
RS = 0.5300E 00					

OPTRON = 0.36699537E 01 OPTDVE = 0.62581232E-01 OPTFI= 0.90712652E 00
OPTDV(KM/S)= 0.12390130E 05 OPTRO(KM)= 0.18649207E 01

FI INIT. DEGREES	ORB.RADIUS /RS	TOTAL DV /OPT.DV	DV AT ORB. /OPT.DV	DV AT RIN /OPT.DV	FI DEGREES	PSI DEGREES	V /VE
-0.9093E 01	0.5100E 01	0.1164E 01	0.8107E 00	0.3533E-00	0.1287E 01	0.1348E 03	0.7232E-01
-0.8093E 01	0.4600E 01	0.1149E 01	0.8350E 00	0.3139E-00	0.1175E 01	0.1343E 03	0.7441E-01
-0.7093E 01	0.4600E 01	0.1134E 01	0.8524E 00	0.2812E-00	0.1162E 01	0.1346E 03	0.7598E-01
-0.6093E 01	0.4100E 01	0.1118E 01	0.8778E 00	0.2402E-00	0.1053E 01	0.1336E 03	0.7814E-01
-0.5093E 01	0.4100E 01	0.1102E 01	0.8935E 00	0.2084E-00	0.1043E 01	0.1342E 03	0.7956E-01
-0.4093E 01	0.4100E 01	0.1086E 01	0.9075E 00	0.1782E-00	0.1034E 01	0.1355E 03	0.8083E-01
-0.3093E 01	0.4100E 01	0.1069E 01	0.9270E 00	0.1423E-00	0.1023E 01	0.1352E 03	0.8257E-01
-0.2093E 01	0.3600E 01	0.1052E 01	0.9498E 00	0.1023E-00	0.9182E 00	0.1340E 03	0.8450E-01
-0.1093E 01	0.3600E 01	0.1035E 01	0.9661E 00	0.6871E-01	0.9100E 00	0.1346E 03	0.8598E-01
-0.9287E-01	0.3600E 01	0.1017E 01	0.9831E 00	0.3429E-01	0.9018E 00	0.1349E 03	0.8750E-01
0.9071E 00	0.3600E 01	0.1000E 01	0.9991E 00	0.1360E-02	0.8946E 00	-0.1659E 03	0.8892E-01
0.1907E 01	0.4100E 01	0.1016E 01	0.9830E 00	0.3320E-01	0.9946E 00	-0.1360E 03	0.8747E-01
0.2907E 01	0.4600E 01	0.1033E 01	0.9653E 00	0.6724E-01	0.1096E 01	-0.1369E 03	0.8583E-01
0.3907E 01	0.4600E 01	0.1048E 01	0.9454E 00	0.1030E-00	0.1106E 01	-0.1365E 03	0.8413E-01
0.4907E 01	0.5100E 01	0.1064E 01	0.9260E 00	0.1382E-00	0.1209E 01	-0.1372E 03	0.8235E-01
0.5907E 01	0.5100E 01	0.1079E 01	0.9058E 00	0.1736E-00	0.1220E 01	-0.1368E 03	0.8063E-01
0.6907E 01	0.5600E 01	0.1094E 01	0.8857E 00	0.2087E-00	0.1325E 01	-0.1371E 03	0.7880E-01
0.7907E 01	0.5600E 01	0.1109E 01	0.8645E 00	0.2443E-00	0.1339E 01	-0.1369E 03	0.7701E-01
0.8907E 01	0.5600E 01	0.1123E 01	0.8471E 00	0.2760E-00	0.1351E 01	-0.1360E 03	0.7552E-01
0.9907E 01	0.5600E 01	0.1137E 01	0.8270E 00	0.3103E-00	0.1366E 01	-0.1357E 03	0.7379E-01
0.1091E 02	0.5600E 01	0.1151E 01	0.8108E 00	0.3406E-00	0.1379E 01	-0.1349E 03	0.7237E-01

OPTIMUM 2-STAGE TRAJECTORY

```
MARS    A-TRAJECTORY
RMIN = 0.1100E 01    RMAX= 0.6100E 01    RIN= 0.3260E 03    RE= 0.6370E 04    PCERR= 1.0000E-04    L= 19
ROIN = 0.1100E 01    FIIN=-0.9000E 02    VIN= 0.2290E-00    VE= 0.2980E 02    ODVI = 0.5555E 05    M= 10
DROIN= 0.5000E 00    DFI = 0.1000E 02    G  = 0.1080E-00    GE= 0.3990E 06    ICI  =  0            N= 10
RS   = 0.5300E 00
OPTRON      = 0.54908393E 00             OPTDVE    = 0.16179125E-00             OPIFI= 0.13636211E-00
OPTDV(KM/S)= 0.18537622E 04              OPTRO(KM)= 0.48213793E 01
```

FI INIT. DEGREES	ORB.RADIUS /RS	TOTAL DV /OPT.DV	DV AT ORB. /OPT.DV	DV AT RIN /OPT.DV	FI DEGREES	PSI DEGREES	V /VE
-0.9000E 02	0.5600E 01	0.1554E 01	0.1297E-00	0.1424E 01	0.7525E 01	0.8768E 02	0.9397E-02
-0.8000E 02	0.5600E 01	0.1544E 01	0.1298E-00	0.1414E 01	0.7475E 01	0.9763E 02	0.9461E-02
-0.7000E 02	0.5600E 01	0.1529E 01	0.1415E-00	0.1387E 01	0.3785E 01	0.1053E 03	0.1914E-01
-0.6000E 02	0.5600E 01	0.1503E 01	0.1626E-00	0.1341E 01	0.2554E 01	0.1130E 03	0.2967E-01
-0.5000E 02	0.5600E 01	0.1469E 01	0.1962E-00	0.1273E 01	0.1942E 01	0.1208E 03	0.4177E-01
-0.4000E 02	0.5600E 01	0.1425E 01	0.2459E-00	0.1179E 01	0.1590E 01	0.1288E 03	0.5599E-01
-0.3000E 02	0.3600E 01	0.1371E 01	0.3708E-00	0.1000E 01	0.9138E 00	0.1343E 03	0.8529E-01
-0.2000E 02	0.1600E 01	0.1285E 01	0.5876E 00	0.6979E 00	0.3961E-00	0.1354E 03	0.1348E-00
-1.0000E 01	0.1100E 01	0.1165E 01	0.7877E 00	0.3770E-00	0.2597E-00	0.1383E 03	0.1800E-00
0.8538E-06	0.1100E 01	0.1028E 01	0.1018E 01	0.1059E-01	0.2370E-00	0.1467E 03	0.2276E-00
0.1000E 02	0.1100E 01	0.1158E 01	0.7966E 00	0.3613E-00	0.2584E-00	-0.1382E 03	0.1819E-00
0.2000E 02	0.1600E 01	0.1277E 01	0.5957E 00	0.6817E 00	0.3935E-00	-0.1354E 03	0.1366E-00
0.3000E 02	0.5600E 01	0.1356E 01	0.3383E-00	0.1020E 01	0.1332E 01	-0.1369E 03	0.7787E-01
0.4000E 02	0.5600E 01	0.1410E 01	0.2551E-00	0.1155E 01	0.1550E 01	-0.1288E 03	0.5837E-01
0.5000E 02	0.5600E 01	0.1454E 01	0.2008E-00	0.1253E 01	0.1894E 01	-0.1209E 03	0.4322E-01
0.6000E 02	0.5600E 01	0.1488E 01	0.1654E-00	0.1323E 01	0.2475E 01	-0.1130E 03	0.3079E-01
0.7000E 02	0.5600E 01	0.1513E 01	0.1427E-00	0.1371E 01	0.3659E 01	-0.1053E 03	0.1985E-01
0.8000E 02	0.5600E 01	0.1529E 01	0.1300E-00	0.1399E 01	0.7264E 01	-0.9764E 02	0.9741E-02
0.9000E 02	0.5600E 01	0.1539E 01	0.1297E-00	0.1409E 01	0.7525E 01	-0.8766E 02	0.9397E-02

OPTIMUM 2-STAGE TRAJECTORY

```
VENUS  H-TRAJECTORY
RMIN = 0.1100E 01    RMAX= 0.6100E 01    RIN= 0.1780E 03    RE= 0.6370E 04    PCERR= 1.0000E-04    L= 19
ROIN = 0.1100E 01    FIIN=-0.9000E 02    VIN= 0.9300E-01    VE= 0.2980E 02    ODVI  = 0.5555E 05   M= 10
DROIN= 0.5000E 00    DFI  = 0.1000E 02   G   = 0.8150E 00   GE= 0.3990E 06    ICI   =  0           N= 10
RS   = 0.9700E 00
OPTRON       = 0.14847188E 02            OPTDVE     = 0.63178787E-01            OPTFI= 0.65072761E 01
OPTDV(KM/S)= 0.91739290E 05              OPTRO(KM)= 0.18827278E 01
```

FI INIT. DEGREES	ORB.RADIUS /RS	TOTAL DV /OPT.DV	DV AT ORB. /OPT.DV	DV AT RIN /OPT.DV	FI DEGREES	PSI DEGREES	V /VE
-0.9000E 02	0.5600E 01	0.2270E 01	0.6745E 00	0.1596E 01	0.1022E 02	0.7541E 02	0.2581E-01
-0.8000E 02	0.5600E 01	0.2204E 01	0.6745E 00	0.1529E 01	0.1022E 02	0.8451E 02	0.2581E-01
-0.7000E 02	0.5600E 01	0.2134E 01	0.6745E 00	0.1459E 01	0.1021E 02	0.9398E 02	0.2581E-01
-0.6000E 02	0.5600E 01	0.2061E 01	0.6847E 00	0.1376E 01	0.9045E 01	0.1017E 03	0.2924E-01
-0.5000E 02	0.5600E 01	0.1967E 01	0.7201E 00	0.1247E 01	0.6891E 01	0.1056E 03	0.3890E-01
-0.4000E 02	0.5600E 01	0.1849E 01	0.7660E 00	0.1083E 01	0.5595E 01	0.1094E 03	0.4881E-01
-0.3000E 02	0.5600E 01	0.1706E 01	0.8224E 00	0.8833E 00	0.4741E 01	0.1130E 03	0.5894E-01
-0.2000E 02	0.5600E 01	0.1540E 01	0.8896E 00	0.6503E 00	0.4140E 01	0.1164E 03	0.6932E-01
-1.0000E 01	0.5600E 01	0.1353E 01	0.9639E 00	0.3889E-00	0.3715E 01	0.1199E 03	0.7951E-01
0.8538E-06	0.5600E 01	0.1146E 01	0.1046E 01	0.1001E-00	0.3397E 01	0.1228E 03	0.8973E-01
0.1000E 02	0.5600E 01	0.1210E 01	0.1011E 01	0.1989E-00	0.3518E 01	-0.1198E 03	0.8550E-01
0.2000E 02	0.5600E 01	0.1397E 01	0.9243E 00	0.4730E-00	0.3920E 01	-0.1165E 03	0.7421E-01
0.3000E 02	0.5600E 01	0.1563E 01	0.8482E 00	0.7148E 00	0.4474E 01	-0.1130E 03	0.6310E-01
0.4000E 02	0.5600E 01	0.1706E 01	0.7837E 00	0.9223E 00	0.5273E 01	-0.1093E 03	0.5217E-01
0.5000E 02	0.5600E 01	0.1825E 01	0.7311E 00	0.1094E 01	0.6492E 01	-0.1056E 03	0.4147E-01
0.6000E 02	0.5600E 01	0.1918E 01	0.6905E 00	0.1228E 01	0.8549E 01	-0.1018E 03	0.3101E-01
0.7000E 02	0.5600E 01	0.1989E 01	0.6745E 00	0.1315E 01	0.1021E 02	-0.9442E 02	0.2581E-01
0.8000E 02	0.5600E 01	0.2059E 01	0.6745E 00	0.1385E 01	0.1022E 02	-0.8393E 02	0.2581E-01
0.9000E 02	0.5600E 01	0.2131E 01	0.6745E 00	0.1456E 01	0.1022E 02	-0.7398E 02	0.2581E-01

fixed and the other trajectory parameters are allowed to vary to give a minimum impulse sum. A saving in impulse can be realized over the previous case. This is shown in Table IX, in which the ΔV's are the percentage of increase in impulse over the single theoretical impulse. The data has been taken from Programs 1 and 7 for the Mars-H-Trajectory. The table shows that there is a considerable savings for large angles--as much as 116.7% of the theoretical optimum value, for a 90° path angle. Of course, this path angle is not very realistic, but there is still a saving of 7.4% for a 10° path angle, which would be about 9.1° in error. The results for smaller variations of path angle are shown in Table X.

When the orbital radius as well as the other trajectory parameters are allowed to vary $(1.1 \leq R_o \leq 6.1)$, and additional saving in impulse can be realized. This is also shown in Table IX. The saving here again is significant for a 90° path angle, 8.2%, while the additional savings for a 10° path angle is only 1.2%. The total savings at 90° is then 124.9% which is 41.6% of the Basic Velocity Sum. The total savings of 8.6% for a 10° path angle is 2.9% of the Basic Velocity Sum. Table X shows a similar trend for smaller path angles; the total savings for 2° path angle (1.1° error) is 1.7% of the theoretical optimum impulse or about 0.6% of the Basic Velocity Sum. In Table XI, comparisons are made for the Mars A and Venus H trajectories, where only the total savings, Δ is shown. Small negative values of Δ occur in a few places in Tables X and XI. This is contrary to what should be expected. But it can be explained as a result of the inaccuracies in the numerical analysis. This illus-

Table IX

Comparison of Single-Stage Correction Methods for Large Path Angles

Mars H-Trajectory

ϕ	ΔV_1	ΔV_2	ΔV_3	Δ_1	Δ_2
90°	1.995	.828	.746	1.167	.082
80°	1.811	.802	.720	1.009	.082
70°	1.613	.770	.690	.843	.080
60°	1.402	.716	.642	.686	.074
50°	1.181	.642	.576	.539	.066
40°	.951	.548	.492	.403	.056
30°	.714	.434	.390	.280	.044
20°	.474	.301	.272	.173	.029
10°	.225	.151	.139	.074	.012
0°	.023	.016	.016	.007	.000
-10°	.271	.183	.177	.098	.006
-20°	.517	.333	.311	.184	.022
-30°	.759	.465	.429	.294	.036
-40°	.995	.579	.531	.416	.048
-50°	1.223	.674	.615	.549	.059
-60°	1.442	.748	.681	.694	.067
-70°	1.650	.801	.729	.849	.072
-80°	1.846	.834	.759	1.012	.075
-90°	2.028	.860	.785	1.168	.075

Legend:

ΔV_1 --Impulse for fixed trajectory (Program 1)

ΔV_2 --Impulse for fixed orbit (Program 7)

ΔV_3 --Impulse of variable orbit (Program 7)

$\Delta_1 = \Delta V_1 - \Delta V_2$

$\Delta_2 = \Delta V_2 - \Delta V_3$

Table X

Comparison of Single-Stage
Correction Methods for
Small Path Angles

Mars H-Trajectory

ϕ	ΔV_1	ΔV_2	ΔV_3	Δ_1	Δ_2
10°	.225	.151	.139	.074	.012
9°	.200	.135	.124	.065	.011
8°	.176	.119	.110	.057	.009
7°	.151	.103	.096	.048	.007
6°	.126	.086	.081	.040	.005
5°	.101	.070	.066	.031	.004
4°	.076	.053	.050	.023	.003
3°	.052	.036	.034	.016	.002
2°	.026	.019	.018	.007	.001
1°	.018	.002	.001	.016	.001
0°	.023	.016	.016	.007	.000
-1°	.048	.033	.033	.015	.000
-2°	.073	.050	.051	.023	-.001
-3°	.098	.068	.068	.030	.000
-4°	.122	.084	.084	.038	.000
-5°	.147	.101	.100	.046	.001
-6°	.172	.118	.117	.054	.001
-7°	.197	.134	.132	.063	.002
-8°	.221	.151	.147	.070	.004
-9°	*	.167	.163	-	.004
-10°	.271	.183	.177	.098	.006

* value not computed by program.

Table XI

Other Comparisons
of Single-Stage Correction
Impulses

ϕ	Mars A-Trajectory ΔV_1	ΔV_3	Δ	Venus H-Trajectory ΔV_1	ΔV_2	Δ
90°	1.949	.530	1.410	1.950	.828	1.122
80°	1.771	.529	1.242	1.749	.757	.992
70°	1.580	.513	1.067	1.534	.689	.845
60°	1.376	.488	.888	1.309	.625	.684
50°	1.162	.454	.703	1.073	.551	.522
40°	.939	.410	.529	.829	.456	.373
30°	.709	.358	.351	.578	.342	.236
20°	.474	.277	.197	.323	.209	.114
10°	.235	.158	.077	.066	.058	.008
0°	.006	.028	- .022	.192	.107	.085
-10°	.247	.165	.082	.448	.283	.165
-20°	.485	.285	.200	.701	.434	.267
-30°	.720	.371	.349	.948	.567	.381
-40°	.950	.425	.525	1.119	.681	.438
-50°	1.172	.469	.703	1.420	.776	.644
-60°	1.386	.503	.883	1.640	.852	.788
-70°	1.589	.529	1.060	1.849	.922	.921
-80°	1.780	.544	1.236	2.042	.990	1.052
-90°	1.957	.554	1.403	2.221	1.054	1.167

trates a point discussed previously on page 46, where the need for a very tight convergence criteria was discussed. Apparently at least $(10)^{-5}$ should be used as a criteria.

Optimum Correction Sequence with Orbial Range

The results of Program 8 are given on pages 112 through 129. The impulse totals, designated FOPT 1, FOPT 2,---FOPT 10, optimums for each number of correction stages from one to ten. The correction radii are number outward from the orbit, i.e. RC 1 is the radius of final orbit and RC 2 is the next correction out from the orbit. The subscripts, which are shown only on page 119, indicate the numbers of the radii in the possible-correction grid. Therefore $RC_{10}2$, $RC_{30}3$, $RC_{90}4$ represents a geometrically spaced correction sequence. For case where FOPT 1 is very large (approx. 10^6), no single correction is possible for the prescribed orbital range.

The results include three Mars H-Trajectory analyses, plus one Mars A and two Venus H problems. One of the Mars H programs was run with a fixed orbital radius to compare with the varying orbit cases. The other two were run to compare the effects of errors of different magnitudes. The first of these programs used 1.5% of the reference velocities for all errors, while the second had a 10% initial error, followed by 1.5% correction errors. This case tacitly assumes that terminal guidance will be more accurate than midcourse guidance, since there are better spatial references available and less distance is traveled between corrections. The Mars A and the Venus H problems also contain 1.5% errors. The

```
 OPTIMUM MARS H-TRAJECTORY FOR ORBIT          RO=3.670

INPUT DATA
       G= 0.1080E-00      VIN= 0.8900E-01      RIN= 0.3260E 03
      RS= 0.5300E 00     VERR= 0.1500E-01    VRERR= 0.1500E-01


LOCAL NORMALIZATION DATA
                    VCS(K/S)= 0.3573E 01    RS(K)= 0.3376E 04
VIN(NORM)= 0.7424E 00    FIER= 0.1500E-01    DELFI= 0.1500E-01


THEORETICAL OPTIMUM TRAJECTORY
      ROX= 0.3670E 01      DVX= 0.5220E 00      FIX= 0.1583E-01
  ROX(K)= 0.1239E 05DVX(K/S)= 0.1865E 01  FIX(D)= 0.9071E 00


INPUT DATA
      ROR= 0.3670E 01     RMAX= 0.3670E 01     RMIN= 0.3670E 01
     RERR= 0.1000E-00


OPTIMUM REFERENCE TRAJECTORY VALUES
      ROR= 0.3670E 01     FIIN= 0.1583E-01 FIIN(D)= 0.9071E 00


OUTER ERROR ANALYSIS
     RLIM= 0.3937E 01        VI= 0.7424E 00      FII= 0.3083E-01


REFERENCE TRAJECTORY PARAMETERS
    FI(D)= 0.9139E 00  PSI(D)= 0.2260E 03THETA(D)=-0.4419E 02
      DVT= 0.1015E 01      DVO= 0.9850E 00       DV= 0.2991E-01
       RO= 0.3670E 01        A= 0.1891E 01        H= 0.3803E 01
       EC= 0.2940E 01


INNER ERROR ANALYSIS
     RLIM= 0.3403E 01        VI= 0.7424E 00      FII= 0.8339E-03


REFERENCE TRAJECTORY PARAMETERS
    FI(D)= 0.9139E 00  PSI(D)= 0.1354E 03THETA(D)= 0.4464E 02
      DVT= 0.1015E 01      DVO= 0.9850E 00       DV= 0.3014E-01
       RO= 0.3670E 01        A= 0.1891E 01        H= 0.3803E 01
       EC= 0.2940E 01
```

OPTIMUM MARS H-TRAJECTORY FOR ORBIT   RO=3.670

N-CORRECTION IMPULSE TOTALS
OUTER ERRORS

```
 FOPT   1= 0.1897E 07      RCO= 0.

 FOPT   2= 0.1445E 01
   RC   1= 0.3931E 01   RC   2= 0.1741E 02   RC

 FOPT   3= 0.1203E 01
   RC   1= 0.3931E 01   RC   2= 0.1741E 02   RC   3= 0.7533E 02
   RC

 FOPT   4= 0.1188E 01
   RC   1= 0.3931E 01   RC   2= 0.1741E 02   RC   3= 0.4552E 02
   RC   4= 0.1191E 03   RC

 FOPT   5= 0.1195E 01
   RC   1= 0.3931E 01   RC   2= 0.1741E 02   RC   3= 0.3621E 02
   RC   4= 0.7533E 02   RC   5= 0.1567E 03   RC

 FOPT   6= 0.1209E 01
   RC   1= 0.3931E 01   RC   2= 0.1741E 02   RC   3= 0.3156E 02
   RC   4= 0.5723E 02   RC   5= 0.1038E 03   RC   6= 0.1882E 03
   RC

 FOPT   7= 0.1226E 01
   RC   1= 0.3931E 01   RC   2= 0.1741E 02   RC   3= 0.2880E 02
   RC   4= 0.4766E 02   RC   5= 0.7886E 02   RC   6= 0.1305E 03
   RC   7= 0.2062E 03   RC

 FOPT   8= 0.1245E 01
   RC   1= 0.3931E 01   RC   2= 0.1741E 02   RC   3= 0.2751E 02
   RC   4= 0.4349E 02   RC   5= 0.6566E 02   RC   6= 0.9914E 02
   RC   7= 0.1497E 03   RC   8= 0.2260E 03   RC

 FOPT   9= 0.1264E 01
   RC   1= 0.3931E 01   RC   2= 0.1741E 02   RC   3= 0.2751E 02
   RC   4= 0.4154E 02   RC   5= 0.5992E 02   RC   6= 0.8642E 02
   RC   7= 0.1246E 03   RC   8= 0.1717E 03   RC   9= 0.2366E 03
   RC

 FOPT  10= 0.1284E 01
   RC   1= 0.3931E 01   RC   2= 0.1741E 02   RC   3= 0.2628E 02
   RC   4= 0.3791E 02   RC   5= 0.5467E 02   RC   6= 0.7533E 02
   RC   7= 0.1038E 03   RC   8= 0.1430E 03   RC   9= 0.1882E 03
   RC  10= 0.2477E 03   RC
```

```
OPTIMUM MARS H-TRAJECTORY FOR ORBIT     RO=3.670

N-CORRECTION IMPULSE TOTALS
INNER ERRORS

FOPT  1= 0.1897E 07      RCO= 0.

FOPT  2= 0.1414E 01
  RC  1= 0.3410E 01    RC  2= 0.1741E 02    RC

FOPT  3= 0.1202E 01
  RC  1= 0.3410E 01    RC  2= 0.1741E 02    RC  3= 0.7533E 02
  RC

FOPT  4= 0.1188E 01
  RC  1= 0.3410E 01    RC  2= 0.1741E 02    RC  3= 0.4552E 02
  RC  4= 0.1246E 03    RC

FOPT  5= 0.1195E 01
  RC  1= 0.3410E 01    RC  2= 0.1741E 02    RC  3= 0.3621E 02
  RC  4= 0.7533E 02    RC  5= 0.1567E 03    RC

FOPT  6= 0.1210E 01
  RC  1= 0.3410E 01    RC  2= 0.1741E 02    RC  3= 0.3156E 02
  RC  4= 0.5723E 02    RC  5= 0.1038E 03    RC  6= 0.1882E 03
  RC

FOPT  7= 0.1227E 01
  RC  1= 0.3410E 01    RC  2= 0.1741E 02    RC  3= 0.3015E 02
  RC  4= 0.4989E 02    RC  5= 0.8255E 02    RC  6= 0.1305E 03
  RC  7= 0.2062E 03    RC

FOPT  8= 0.1245E 01
  RC  1= 0.3410E 01    RC  2= 0.1741E 02    RC  3= 0.2751E 02
  RC  4= 0.4349E 02    RC  5= 0.6566E 02    RC  6= 0.9914E 02
  RC  7= 0.1497E 03    RC  8= 0.2260E 03    RC

FOPT  9= 0.1265E 01
  RC  1= 0.3410E 01    RC  2= 0.1741E 02    RC  3= 0.2751E 02
  RC  4= 0.4154E 02    RC  5= 0.5992E 02    RC  6= 0.8642E 02
  RC  7= 0.1246E 03    RC  8= 0.1717E 03    RC  9= 0.2366E 03
  RC

FOPT 10= 0.1285E 01
  RC  1= 0.3410E 01    RC  2= 0.1741E 02    RC  3= 0.2628E 02
  RC  4= 0.3791E 02    RC  5= 0.5467E 02    RC  6= 0.7533E 02
  RC  7= 0.1038E 03    RC  8= 0.1430E 03    RC  9= 0.1882E 03
  RC 10= 0.2477E 03    RC
```

```
 OPTIMUM MARS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

INPUT DATA
        G= 0.1080E-00       VIN= 0.8900E-01     RIN= 0.3260E 03
       RS= 0.5300E 00      VERR= 0.1500E-01   VRERR= 0.1500E-01


LOCAL NORMALIZATION DATA
                     VCS(K/S)= 0.3573E 01   RS(K)= 0.3376E 04
VIN(NORM)= 0.7424E 00   FIER= 0.1500E-01   DELFI= 0.1500E-01


THEORETICAL OPTIMUM TRAJECTORY
      ROX= 0.3670E 01       DVX= 0.5220E 00     FIX= 0.1583E-01
   ROX(K)= 0.1239E 05DVX(K/S)= 0.1865E 01  FIX(D)= 0.9071E 00


INPUT DATA
      ROR= 0.               RMAX= 0.6100E 01    RMIN= 0.1100E 01
     RERR= 0.1000E-00


OPTIMUM REFERENCE TRAJECTORY VALUES
      ROR= 0.3670E 01      FIIN= 0.1583E-01 FIIN(D)= 0.9071E 00



OUTER ERROR ANALYSIS
     RLIM= 0.6610E 01        VI= 0.7424E 00     FII= 0.3083E-01


REFERENCE TRAJECTORY PARAMETERS
    FI(D)= 0.9745E 00  PSI(D)= 0.3364E 03THETA(D)=-0.1547E 03
      DVT= 0.1014E 01       DVO= 0.1037E 01      DV= 0.4735E-01
       RO= 0.4239E 01         A= 0.1727E 01       H= 0.4241E 01
       EC= 0.3454E 01




INNER ERROR ANALYSIS
     RLIM= 0.1090E 01        VI= 0.7424E 00     FII= 0.8335E-03


REFERENCE TRAJECTORY PARAMETERS
    FI(D)= 0.8535E 00  PSI(D)= 0.4137E 03THETA(D)=-0.2336E 03
      DVT= 0.1015E 01       DVO= 0.1011E 01      DV= 0.2511E-01
       RO= 0.3461E 01         A= 0.1796E 01       H= 0.3643E 01
       EC= 0.2927E 01
```

OPTIMUM MARS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

N-CORRECTION IMPULSE TOTALS
OUTER ERRORS

```
FOPT   1= 0.1897E 07      RCO= 0.

FOPT   2= 0.1143E 01
  RC   1= 0.6567E 01   RC   2= 0.1677E 03   RC

FOPT   3= 0.1162E 01
  RC   1= 0.6567E 01   RC   2= 0.1677E 03   RC   3= 0.2391E 03
  RC

FOPT   4= 0.1183E 01
  RC   1= 0.6567E 01   RC   2= 0.1677E 03   RC   3= 0.2093E 03
  RC   4= 0.2612E 03   RC

FOPT   5= 0.1204E 01
  RC   1= 0.6567E 01   RC   2= 0.1677E 03   RC   3= 0.2002E 03
  RC   4= 0.2391E 03   RC   5= 0.2854E 03   RC

FOPT   6= 0.1226E 01
  RC   1= 0.6567E 01   RC   2= 0.1677E 03   RC   3= 0.1915E 03
  RC   4= 0.2188E 03   RC   5= 0.2499E 03   RC   6= 0.2854E 03
  RC

FOPT   7= 0.1248E 01
  RC   1= 0.6567E 01   RC   2= 0.1677E 03   RC   3= 0.1915E 03
  RC   4= 0.2188E 03   RC   5= 0.2499E 03   RC   6= 0.2730E 03
  RC   7= 0.2984E 03   RC

FOPT   8= 0.1270E 01
  RC   1= 0.6567E 01   RC   2= 0.1677E 03   RC   3= 0.1915E 03
  RC   4= 0.2093E 03   RC   5= 0.2287E 03   RC   6= 0.2499E 03
  RC   7= 0.2730E 03   RC   8= 0.2984E 03   RC

FOPT   9= 0.1292E 01
  RC   1= 0.6567E 01   RC   2= 0.1677E 03   RC   3= 0.1832E 03
  RC   4= 0.2002E 03   RC   5= 0.2188E 03   RC   6= 0.2391E 03
  RC   7= 0.2612E 03   RC   8= 0.2854E 03   RC   9= 0.3119E 03
  RC

FOPT  10= 0.1314E 01
  RC   1= 0.6567E 01   RC   2= 0.1677E 03   RC   3= 0.1832E 03
  RC   4= 0.2002E 03   RC   5= 0.2188E 03   RC   6= 0.2391E 03
  RC   7= 0.2612E 03   RC   8= 0.2854E 03   RC   9= 0.2984E 03
  RC  10= 0.3119E 03   RC
```

OPTIMUM MARS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

N-CORRECTION IMPULSE TOTALS
INNER ERRORS

```
FOPT   1= 0.1897E 07      RCO= 0.

FOPT   2= 0.1130E 01
  RC   1= 0.1982E 01    RC   2= 0.1022E 03    RC

FOPT   3= 0.1137E 01
  RC   1= 0.2158E 01    RC   2= 0.8896E 02    RC   3= 0.1703E 03
  RC

FOPT   4= 0.1154E 01
  RC   1= 0.2264E 01    RC   2= 0.8108E 02    RC   3= 0.1289E 03
  RC   4= 0.2050E 03    RC

FOPT   5= 0.1174E 01
  RC   1= 0.2264E 01    RC   2= 0.8108E 02    RC   3= 0.1175E 03
  RC   4= 0.1703E 03    RC   5= 0.2356E 03    RC

FOPT   6= 0.1194E 01
  RC   1= 0.2314E 01    RC   2= 0.7741E 02    RC   3= 0.1071E 03
  RC   4= 0.1415E 03    RC   5= 0.1869E 03    RC   6= 0.2468E 03
  RC

FOPT   7= 0.1215E 01
  RC   1= 0.2314E 01    RC   2= 0.7741E 02    RC   3= 0.1022E 03
  RC   4= 0.1289E 03    RC   5= 0.1626E 03    RC   6= 0.2050E 03
  RC   7= 0.2585E 03    RC

FOPT   8= 0.1236E 01
  RC   1= 0.2314E 01    RC   2= 0.7741E 02    RC   3= 0.9761E 02
  RC   4= 0.1231E 03    RC   5= 0.1552E 03    RC   6= 0.1869E 03
  RC   7= 0.2249E 03    RC   8= 0.2708E 03    RC

FOPT   9= 0.1257E 01
  RC   1= 0.2361E 01    RC   2= 0.7390E 02    RC   3= 0.9319E 02
  RC   4= 0.1122E 03    RC   5= 0.1351E 03    RC   6= 0.1626E 03
  RC   7= 0.1957E 03    RC   8= 0.2356E 03    RC   9= 0.2837E 03
  RC

FOPT  10= 0.1278E 01
  RC   1= 0.2361E 01    RC   2= 0.7390E 02    RC   3= 0.9319E 02
  RC   4= 0.1122E 03    RC   5= 0.1351E 03    RC   6= 0.1626E 03
  RC   7= 0.1869E 03    RC   8= 0.2147E 03    RC   9= 0.2468E 03
  RC  10= 0.2837E 03    RC
```

OPTIMUM MARS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

```
INPUT DATA
         G= 0.1080E-00      VIN= 0.6900E-01      RIN= 0.3260E 03
        RS= 0.5300E 00     VERR= 0.1000E-00    VRERR= 0.1500E-01


LOCAL NORMALIZATION DATA
                       VCS(K/S)= 0.3573E 01    RS(K)= 0.3376E 04
VIN(NORM)= 0.7424E 00      FIER= 0.9967E-01    DELFI= 0.1500E-01


THEORETICAL OPTIMUM TRAJECTORY
       ROX= 0.3670E 01      DVX= 0.5220E 00      FIX= 0.1583E-01
    ROX(K)= 0.1239E 05DVX(K/S)= 0.1865E 01   FIX(D)= 0.9071E 00


INPUT DATA
       ROR= 0.             RMAX= 0.6100E 01     RMIN= 0.1100E 01
      RERR= 0.1000E-00


OPTIMUM REFERENCE TRAJECTORY VALUES
       ROR= 0.3670E 01     FIIN= 0.1583E-01 FIIN(D)= 0.9071E 00


OUTER ERROR ANALYSIS
      RLIM= 0.6610E 01       VI= 0.7461E 00      FII= 0.1155E-00


REFERENCE TRAJECTORY PARAMETERS
     FI(D)= 0.1246E 01  PSI(D)= 0.2244E 03THETA(D)=-0.3779E 02
       DVT= 0.1096E 01      DVO= 0.9003E 00       DV= 0.1956E-00
        RO= 0.5239E 01        A= 0.2270E 01        H= 0.4739E 01
        EC= 0.3308E 01


INNER ERROR ANALYSIS
      RLIM= 0.1090E 01       VI= 0.7461E 00      FII=-0.8384E-01


REFERENCE TRAJECTORY PARAMETERS
     FI(D)= 0.9984E 00  PSI(D)= 0.1272E 03THETA(D)= 0.4799E 02
       DVT= 0.1103E 01      DVO= 0.9246E 00       DV= 0.1791E-00
        RO= 0.4017E 01        A= 0.2147E 01        H= 0.3903E 01
        EC= 0.2871E 01
```

OPTIMUM MARS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

N-CORRECTION IMPULSE TOTALS
OUTER ERRORS

FOPT 1= 0.1897E 07 RCO= 0.

FOPT 2= 0.1170E 01
RC 1= 0.6576E 01 RC_{70} 2= 0.9205E 02 RC

FOPT 3= 0.1174E 01
RC 1= 0.6576E 01 RC_{70} 2= 0.9205E 02 RC_{85} 3= 0.1732E 03
RC

FOPT 4= 0.1190E 01
RC 1= 0.6576E 01 RC_{70} 2= 0.9205E 02 RC_{80} 3= 0.1403E 03
RC_{90} 4= 0.2139E 03 RC

FOPT 5= 0.1208E 01
RC 1= 0.6576E 01 RC_{70} 2= 0.9205E 02 RC_{78} 3= 0.1290E 03
RC_{86} 4= 0.1807E 03 RC_{93} 5= 0.2427E 03 RC

FOPT 6= 0.1226E 01
RC 1= 0.6576E 01 RC_{70} 2= 0.9205E 02 RC_{76} 3= 0.1185E 03
RC_{82} 4= 0.1527E 03 RC_{88} 5= 0.1966E 03 RC_{94} 6= 0.2532E 03
RC

FOPT 7= 0.1245E 01
RC 1= 0.6576E 01 RC_{70} 2= 0.9205E 02 RC_{76} 3= 0.1185E 03
RC_{81} 4= 0.1464E 03 RC_{86} 5= 0.1807E 03 RC_{91} 6= 0.2231E 03
RC_{96} 7= 0.2754E 03 RC

FOPT 8= 0.1264E 01
RC 1= 0.6576E 01 RC_{70} 2= 0.9205E 02 RC_{75} 3= 0.1137E 03
RC_{80} 4= 0.1403E 03 RC_{84} 5= 0.1661E 03 RC_{88} 6= 0.1966E 03
RC_{92} 7= 0.2327E 03 RC_{96} 8= 0.2754E 03 RC

FOPT 9= 0.1283E 01
RC 1= 0.6576E 01 RC_{70} 2= 0.9205E 02 RC_{75} 3= 0.1137E 03
RC_{79} 4= 0.1345E 03 RC_{83} 5= 0.1592E 03 RC_{87} 6= 0.1885E 03
RC_{91} 7= 0.2231E 03 RC_{94} 8= 0.2532E 03 RC_{97} 9= 0.2873E 03
RC

FOPT 10= 0.1302E 01
RC 1= 0.6576E 01 RC_{70} 2= 0.9205E 02 RC_{75} 3= 0.1137E 03
RC_{79} 4= 0.1345E 03 RC_{83} 5= 0.1592E 03 RC_{86} 6= 0.1807E 03
RC[illegible] 7= 0.2050E 03 RC_{92} 8= 0.2327E 03 RC_{95} 9= 0.2641E 03
RC_{98} 10= 0.2996E 03 RC

OPTIMUM MARS N-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

N-CORRECTION IMPULSE TOTALS
INNER ERRORS

```
FOPT  1= 0.1897E 07      RCO= 0.

FOPT  2= 0.1183E 01
  RC  1= 0.2344E 01   RC  2= 0.1162E 03   RC

FOPT  3= 0.1193E 01
  RC  1= 0.2598E 01   RC  2= 0.9709E 02   RC  3= 0.1819E 03
  RC

FOPT  4= 0.1209E 01
  RC  1= 0.2655E 01   RC  2= 0.9283E 02   RC  3= 0.1454E 03
  RC  4= 0.2177E 03   RC

FOPT  5= 0.1227E 01
  RC  1= 0.2710E 01   RC  2= 0.8876E 02   RC  3= 0.1271E 03
  RC  4= 0.1740E 03   RC  5= 0.2381E 03   RC

FOPT  6= 0.1246E 01
  RC  1= 0.2710E 01   RC  2= 0.8876E 02   RC  3= 0.1162E 03
  RC  4= 0.1521E 03   RC  5= 0.1990E 03   RC  6= 0.2605E 03
  RC

FOPT  7= 0.1265E 01
  RC  1= 0.2763E 01   RC  2= 0.8486E 02   RC  3= 0.1111E 03
  RC  4= 0.1390E 03   RC  5= 0.1740E 03   RC  6= 0.2177E 03
  RC  7= 0.2724E 03   RC

FOPT  8= 0.1285E 01
  RC  1= 0.2763E 01   RC  2= 0.8486E 02   RC  3= 0.1062E 03
  RC  4= 0.1329E 03   RC  5= 0.1590E 03   RC  6= 0.1903E 03
  RC  7= 0.2277E 03   RC  8= 0.2724E 03   RC

FOPT  9= 0.1304E 01
  RC  1= 0.2763E 01   RC  2= 0.8486E 02   RC  3= 0.1062E 03
  RC  4= 0.1271E 03   RC  5= 0.1521E 03   RC  6= 0.1819E 03
  RC  7= 0.2177E 03   RC  8= 0.2491E 03   RC  9= 0.2849E 03
  RC

FOPT 10= 0.1324E 01
  RC  1= 0.2763E 01   RC  2= 0.8486E 02   RC  3= 0.1015E 03
  RC  4= 0.1215E 03   RC  5= 0.1454E 03   RC  6= 0.1663E 03
  RC  7= 0.1903E 03   RC  8= 0.2177E 03   RC  9= 0.2491E 03
  RC 10= 0.2849E 03   RC
```

```
 CPTIMUM MARS A-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

INPUT DATA
          G= 0.1080E-00       VIN= 0.2290E-00      RIN= 0.3260E 03
         RS= 0.5300E 00      VERR= 0.1500E-01    VRERR= 0.1500E-01


LOCAL NURMALIZATION DATA
                         VCS(K/S)= 0.3573E 01    RS(K)= 0.3376E 04
VIN(NORM)= 0.1910E 01    FIER= 0.1500E-01    DELFI= 0.1500E-01


THEORETICAL OPTIMUM TRAJECTORY
        ROX= 0.5491E 00       DVX= 0.1350E 01      FIX= 0.2380E-02
    ROX(K)= 0.1854E 04DVX(K/S)= 0.4821E 01   FIX(D)= 0.1364E-00


INPUT DATA
        ROR= 0.               RMAX= 0.6100E 01     RMIN= 0.1100E 01
       RERR= 0.1000E-00


OPTIMUM REFERENCE TRAJECTORY VALUES
        ROR= 0.1100E 01      FIIN= 0.4128E-02 FIIN(D)= 0.2365E-00


OUTER ERROR ANALYSIS
     RLIM= 0.6610E 01           VI= 0.1910E 01      FII= 0.1913E-01


REFERENCE TRAJECTORY PARAMETERS
     FI(D)= 0.2380E-00  PSI(D)= 0.2169E 03THETA(D)=-0.3576E 02
       DVT= 0.1037E 01       DVO= 0.1002E 01       DV= 0.3553E-01
        RO= 0.1100E 01         A= 0.2860E-00        H= 0.2535E 01
        EC= 0.4847E 01



INNER ERROR ANALYSIS
     RLIM= 0.1090E 01           VI= 0.1910E 01      FII=-0.1087E-01


REFERENCE TRAJECTORY PARAMETERS
     FI(D)= 0.2380E-00  PSI(D)= 0.1435E 03THETA(D)= 0.3586E 02
       DVT= 0.1037E 01       DVO= 0.1002E 01       DV= 0.3557E-01
        RO= 0.1100E 01         A= 0.2860E-00        H= 0.2535E 01
        EC= 0.4847E 01
```

OPTIMUM MARS A-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

```
N-CORRECTION IMPULSE TOTALS
OUTER ERRORS

 FOPT  1= 0.1183E 01      RCO= 0.5970E 01

 FOPT  2= 0.1173E 01
   RC  1= 0.2908E 01   RC  2= 0.1215E 03   RC

 FOPT  3= 0.1179E 01
   RC  1= 0.2170E 01   RC  2= 0.7202E 02   RC  3= 0.1532E 03
   RC

 FOPT  4= 0.1192E 01
   RC  1= 0.1948E 01   RC  2= 0.5709E 02   RC  3= 0.1020E 03
   RC  4= 0.1824E 03   RC

 FOPT  5= 0.1209E 01
   RC  1= 0.1855E 01   RC  2= 0.5083E 02   RC  3= 0.8089E 02
   RC  4= 0.1287E 03   RC  5= 0.2048E 03   RC

 FOPT  6= 0.1227E 01
   RC  1= 0.1734E 01   RC  2= 0.4270E 02   RC  3= 0.6412E 02
   RC  4= 0.9628E 02   RC  5= 0.1446E 03   RC  6= 0.2171E 03
   RC

 FOPT  7= 0.1246E 01
   RC  1= 0.1698E 01   RC  2= 0.4029E 02   RC  3= 0.5709E 02
   RC  4= 0.8089E 02   RC  5= 0.1146E 03   RC  6= 0.1624E 03
   RC  7= 0.2301E 03   RC

 FOPT  8= 0.1266E 01
   RC  1= 0.1698E 01   RC  2= 0.4029E 02   RC  3= 0.5709E 02
   RC  4= 0.7632E 02   RC  5= 0.1020E 03   RC  6= 0.1364E 03
   RC  7= 0.1824E 03   RC  8= 0.2438E 03   RC

 FOPT  9= 0.1286E 01
   RC  1= 0.1665E 01   RC  2= 0.3802E 02   RC  3= 0.5083E 02
   RC  4= 0.6795E 02   RC  5= 0.9085E 02   RC  6= 0.1215E 03
   RC  7= 0.1624E 03   RC  8= 0.2048E 03   RC  9= 0.2584E 03
   RC

 FOPT 10= 0.1306E 01
   RC  1= 0.1665E 01   RC  2= 0.3802E 02   RC  3= 0.5083E 02
   RC  4= 0.6412E 02   RC  5= 0.8089E 02   RC  6= 0.1020E 03
   RC  7= 0.1287E 03   RC  8= 0.1624E 03   RC  9= 0.2048E 03
   RC 10= 0.2584E 03   RC
```

OPTIMUM MARS A-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

```
N-CORRECTION IMPULSE TOTALS
INNER ERRORS

 FOPT  1= 0.7336E 06       RCO= 0.

 FOPT  2= 0.3575E 01
   RC  1= 0.1127E 01    RC  2= 0.3316E 01    RC

 FOPT  3= 0.2074E 01
   RC  1= 0.1093E 01    RC  2= 0.1166E 01    RC  3= 0.1591E 02
   RC

 FOPT  4= 0.1620E 01
   RC  1= 0.1093E 01    RC  2= 0.1166E 01    RC  3= 0.4433E 01
   RC  4= 0.3802E 02    RC

 FOPT  5= 0.1496E 01
   RC  1= 0.1093E 01    RC  2= 0.1166E 01    RC  3= 0.2629E 01
   RC  4= 0.1261E 02    RC  5= 0.6412E 02    RC

 FOPT  6= 0.1452E 01
   RC  1= 0.1093E 01    RC  2= 0.1166E 01    RC  3= 0.1966E 01
   RC  4= 0.6282E 01    RC  5= 0.2254E 02    RC  6= 0.8572E 02
   RC

 FOPT  7= 0.1437E 01
   RC  1= 0.1093E 01    RC  2= 0.1166E 01    RC  3= 0.1652E 01
   RC  4= 0.3947E 01    RC  5= 0.1190E 02    RC  6= 0.3587E 02
   RC  7= 0.1081E 03    RC

 FOPT  8= 0.1436E 01
   RC  1= 0.1093E 01    RC  2= 0.1166E 01    RC  3= 0.1559E 01
   RC  4= 0.3129E 01    RC  5= 0.7924E 01    RC  6= 0.2007E 02
   RC  7= 0.5083E 02    RC  8= 0.1287E 03    RC

 FOPT  9= 0.1443E 01
   RC  1= 0.1093E 01    RC  2= 0.1166E 01    RC  3= 0.1471E 01
   RC  4= 0.2629E 01    RC  5= 0.5593E 01    RC  6= 0.1261E 02
   RC  7= 0.2844E 02    RC  8= 0.6412E 02    RC  9= 0.1446E 03
   RC

 FOPT 10= 0.1453E 01
   RC  1= 0.1093E 01    RC  2= 0.1166E 01    RC  3= 0.1388E 01
   RC  4= 0.2208E 01    RC  5= 0.4183E 01    RC  6= 0.6398E 01
   RC  7= 0.1787E 02    RC  8= 0.3802E 02    RC  9= 0.8089E 02
   RC 10= 0.1624E 03    RC
```

```
 OPTIMUM VENUS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

INPUT DATA
        G= 0.8150E 00       VIN= 0.9300E-01      RIN= 0.1780E 03
       RS= 0.9700E 00      VERR= 0.1000E-00    VRERR= 1.0000E-02


LOCAL NORMALIZATION DATA
                     VCS(K/S)= 0.7255E 01     RS(K)= 0.6179E 04
VIN(NORM)= 0.3820E-00    FIER= 0.9967E-01    DELFI= 1.0000E-02


THEORETICAL OPTIMUM TRAJECTORY
      ROX= 0.1485E 02       DVX= 0.2595E-00      FIX= 0.1136E-00
  ROX(K)= 0.9174E 05DVX(K/S)= 0.1883E 01   FIX(D)= 0.6507E 01


INPUT DATA
      ROR= 0.               RMAX= 0.6100E 01     RMIN= 0.1100E 01
     RERR= 0.1000E-00


OPTIMUM REFERENCE TRAJECTORY VALUES
      ROR= 0.6100E 01     FIIN= 0.6105E-01 FIIN(D)= 0.3498E 01


 OUTER ERROR ANALYSIS
     RLIM= 0.6610E 01        VI= 0.3839E-00      FII= 0.1607E-00


 REFERENCE TRAJECTORY PARAMETERS
    FI(D)= 0.3676E 01  PSI(D)= 0.2385E 03THETA(D)=-0.4924E 02
      DVT= 0.1180E 01     DVO= 0.1006E 01        DV= 0.1746E-00
       RO= 0.6100E 01       A= 0.8658E 01         H= 0.4062E 01
       EC= 0.1705E 01



 INNER ERROR ANALYSIS
     RLIM= 0.1090E 01        VI= 0.3839E-00      FII=-0.3862E-01


 REFERENCE TRAJECTORY PARAMETERS
    FI(D)= 0.3653E 01  PSI(D)= 0.1238E 03THETA(D)= 0.5401E 02
      DVT= 0.1187E 01     DVO= 0.1012E 01        DV= 0.1748E-00
       RO= 0.6100E 01       A= 0.8492E 01         H= 0.4073E 01
       EC= 0.1718E 01
```

OPTIMUM VENUS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

```
N-CORRECTION IMPULSE TOTALS
OUTER ERRORS

 FOPT  1= 0.3815E 07     RCO= 0.

 FOPT  2= 0.1212E 01
   RC  1= 0.6609E 01   RC  2= 0.5522E 02   RC

 FOPT  3= 0.1218E 01
   RC  1= 0.6609E 01   RC  2= 0.5522E 02   RC  3= 0.9915E 02
   RC

 FOPT  4= 0.1230E 01
   RC  1= 0.6609E 01   RC  2= 0.5522E 02   RC  3= 0.8639E 02
   RC  4= 0.1262E 03   RC

 FOPT  5= 0.1243E 01
   RC  1= 0.6609E 01   RC  2= 0.5522E 02   RC  3= 0.8064E 02
   RC  4= 0.1099E 03   RC  5= 0.1448E 03   RC

 FOPT  6= 0.1257E 01
   RC  1= 0.6609E 01   RC  2= 0.5522E 02   RC  3= 0.7792E 02
   RC  4= 0.1026E 03   RC  5= 0.1306E 03   RC  6= 0.1551E 03
   RC

 FOPT  7= 0.1270E 01
   RC  1= 0.6609E 01   RC  2= 0.5522E 02   RC  3= 0.7792E 02
   RC  4= 0.1026E 03   RC  5= 0.1262E 03   RC  6= 0.1499E 03
   RC  7= 0.1662E 03   RC

 FOPT  8= 0.1284E 01
   RC  1= 0.6609E 01   RC  2= 0.5522E 02   RC  3= 0.7792E 02
   RC  4= 0.1026E 03   RC  5= 0.1262E 03   RC  6= 0.1448E 03
   RC  7= 0.1605E 03   RC  8= 0.1720E 03   RC

 FOPT  9= 0.1298E 01
   RC  1= 0.6609E 01   RC  2= 0.5522E 02   RC  3= 0.7792E 02
   RC  4= 0.1026E 03   RC  5= 0.1262E 03   RC  6= 0.1448E 03
   RC  7= 0.1605E 03   RC  8= 0.1662E 03   RC  9= 0.1720E 03
   RC

 FOPT 10= 0.1312E 01
   RC  1= 0.6609E 01   RC  2= 0.5522E 02   RC  3= 0.7528E 02
   RC  4= 0.9915E 02   RC  5= 0.1219E 03   RC  6= 0.1399E 03
   RC  7= 0.1551E 03   RC  8= 0.1605E 03   RC  9= 0.1662E 03
   RC 10= 0.1720E 03   RC
```

OPTIMUM VENUS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

N-CORRECTION IMPULSE TOTALS
INNER ERRORS

```
FOPT  1= 0.1241E 01      RC0= 0.4634E 01

FOPT  2= 0.1239E 01
  RC  1= 0.5300E 01   RC  2= 0.9255E 02   RC

FOPT  3= 0.1251E 01
  RC  1= 0.5417E 01   RC  2= 0.7792E 02   RC  3= 0.1219E 03
  RC

FOPT  4= 0.1264E 01
  RC  1= 0.5459E 01   RC  2= 0.7273E 02   RC  3= 0.1026E 03
  RC  4= 0.1399E 03   RC

FOPT  5= 0.1277E 01
  RC  1= 0.5479E 01   RC  2= 0.7027E 02   RC  3= 0.9579E 02
  RC  4= 0.1219E 03   RC  5= 0.1499E 03   RC

FOPT  6= 0.1291E 01
  RC  1= 0.5479E 01   RC  2= 0.7027E 02   RC  3= 0.9255E 02
  RC  4= 0.1178E 03   RC  5= 0.1399E 03   RC  6= 0.1605E 03
  RC

FOPT  7= 0.1305E 01
  RC  1= 0.5479E 01   RC  2= 0.7027E 02   RC  3= 0.9255E 02
  RC  4= 0.1178E 03   RC  5= 0.1399E 03   RC  6= 0.1605E 03
  RC  7= 0.1720E 03   RC

FOPT  8= 0.1319E 01
  RC  1= 0.5479E 01   RC  2= 0.7027E 02   RC  3= 0.9255E 02
  RC  4= 0.1178E 03   RC  5= 0.1399E 03   RC  6= 0.1551E 03
  RC  7= 0.1662E 03   RC  8= 0.1720E 03   RC

FOPT  9= 0.1333E 01
  RC  1= 0.5479E 01   RC  2= 0.7027E 02   RC  3= 0.9255E 02
  RC  4= 0.1138E 03   RC  5= 0.1352E 03   RC  6= 0.1499E 03
  RC  7= 0.1605E 03   RC  8= 0.1662E 03   RC  9= 0.1720E 03
  RC

FOPT 10= 0.1346E 01
  RC  1= 0.5479E 01   RC  2= 0.7027E 02   RC  3= 0.9255E 02
  RC  4= 0.1138E 03   RC  5= 0.1306E 03   RC  6= 0.1448E 03
  RC  7= 0.1551E 03   RC  8= 0.1605E 03   RC  9= 0.1662E 03
  RC 10= 0.1720E 03   RC
```

OPTIMUM VENUS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 16.1

```
INPUT DATA
       G= 0.8150E 00      VIN= 0.9300E-01      RIN= 0.1780E 03
      RS= 0.9700E 00     VERR= 0.1500E-01    VRERR= 0.1500E-01


LOCAL NORMALIZATION DATA
                     VCS(K/S)= 0.7255E 01    RS(K)= 0.6179E 04
VIN(NORM)= 0.3820E-00    FIER= 0.1500E-01    DELFI= 0.1500E-01


THEORETICAL OPTIMUM TRAJECTORY
     ROX= 0.1485E 02      DVX= 0.2595E-00      FIX= 0.1136E-00
  ROX(K)= 0.9174E 05DVX(K/S)= 0.1883E 01  FIX(D)= 0.6507E 01


INPUT DATA
     ROR= 0.              RMAX= 0.1610E 02    RMIN= 0.1100E 01
    RERR= 0.1000E-00


OPTIMUM REFERENCE TRAJECTORY VALUES
     ROR= 0.1485E 02     FIIN= 0.1136E-00 FIIN(D)= 0.6507E 01



OUTER ERROR ANALYSIS
    RLIM= 0.1761E 02        VI= 0.3821E-00      FII= 0.1286E-00


REFERENCE TRAJECTORY PARAMETERS
   FI(D)= 0.6948E 01  PSI(D)= 0.2256E 03THETA(D)=-0.3822E 02
     DVT= 0.1008E 01     DVO= 0.9904E 00       DV= 0.1721E-01
      RO= 0.1610E 02       A= 0.7571E 01        H= 0.8152E 01
      EC= 0.3126E 01



INNER ERROR ANALYSIS
    RLIM= 0.1090E 01        VI= 0.3821E-00      FII= 0.9857E-01


REFERENCE TRAJECTORY PARAMETERS
   FI(D)= 0.5620E 01  PSI(D)= 0.3613E 03THETA(D)=-0.1757E 03
     DVT= 0.1003E 01     DVO= 0.1009E 01       DV= 0.9691E-02
      RO= 0.1229E 02       A= 0.7317E 01        H= 0.6703E 01
      EC= 0.2680E 01
```

OPTIMUM VENUS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 16.1

N-CORRECTION IMPULSE TOTALS
OUTER ERRORS

```
FOPT   1= 0.3815E 07      RCO= 0.

FOPT   2= 0.1049E 01
  RC   1= 0.1758E 02   RC  2= 0.9882E 02   RC

FOPT   3= 0.1068E 01
  RC   1= 0.1758E 02   RC  2= 0.9882E 02   RC  3= 0.1359E 03
  RC

FOPT   4= 0.1090E 01
  RC   1= 0.1758E 02   RC  2= 0.9882E 02   RC  3= 0.1263E 03
  RC   4= 0.1536E 03   RC

FOPT   5= 0.1111E 01
  RC   1= 0.1758E 02   RC  2= 0.9882E 02   RC  3= 0.1202E 03
  RC   4= 0.1428E 03   RC  5= 0.1614E 03   RC

FOPT   6= 0.1133E 01
  RC   1= 0.1758E 02   RC  2= 0.9882E 02   RC  3= 0.1202E 03
  RC   4= 0.1393E 03   RC  5= 0.1575E 03   RC  6= 0.1695E 03
  RC

FOPT   7= 0.1155E 01
  RC   1= 0.1758E 02   RC  2= 0.9882E 02   RC  3= 0.1202E 03
  RC   4= 0.1393E 03   RC  5= 0.1575E 03   RC  6= 0.1695E 03
  RC   7= 0.1737E 03   RC

FOPT   8= 0.1177E 01
  RC   1= 0.1758E 02   RC  2= 0.9882E 02   RC  3= 0.1202E 03
  RC   4= 0.1393E 03   RC  5= 0.1536E 03   RC  6= 0.1654E 03
  RC   7= 0.1695E 03   RC  8= 0.1737E 03   RC

FOPT   9= 0.1199E 01
  RC   1= 0.1758E 02   RC  2= 0.9882E 02   RC  3= 0.1202E 03
  RC   4= 0.1393E 03   RC  5= 0.1536E 03   RC  6= 0.1614E 03
  RC   7= 0.1654E 03   RC  8= 0.1695E 03   RC  9= 0.1737E 03
  RC

FOPT  10= 0.1221E 01
  RC   1= 0.1758E 02   RC  2= 0.9882E 02   RC  3= 0.1173E 03
  RC   4= 0.1359E 03   RC  5= 0.1499E 03   RC  6= 0.1575E 03
  RC   7= 0.1614E 03   RC  8= 0.1654E 03   RC  9= 0.1695E 03
  RC  10= 0.1737E 03   RC
```

OPTIMUM VENUS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 16.1

```
N-CORRECTION IMPULSE TOTALS
INNER ERRORS

 FOPT  1= 0.1029E 01     RCO= 0.9703E 01

 FOPT  2= 0.1051E 01
   RC  1= 0.9768E 01   RC  2= 0.1732E 03   RC

 FOPT  3= 0.1074E 01
   RC  1= 0.9832E 01   RC  2= 0.1686E 03   RC  3= 0.1732E 03
   RC

 FOPT  4= 0.1096E 01
   RC  1= 0.9894E 01   RC  2= 0.1640E 03   RC  3= 0.1686E 03
   RC  4= 0.1732E 03   RC

 FOPT  5= 0.1119E 01
   RC  1= 0.9954E 01   RC  2= 0.1596E 03   RC  3= 0.1640E 03
   RC  4= 0.1686E 03   RC  5= 0.1732E 03   RC

 FOPT  6= 0.1141E 01
   RC  1= 0.1001E 02   RC  2= 0.1553E 03   RC  3= 0.1596E 03
   RC  4= 0.1640E 03   RC  5= 0.1686E 03   RC  6= 0.1732E 03
   RC

 FOPT  7= 0.1164E 01
   RC  1= 0.1007E 02   RC  2= 0.1511E 03   RC  3= 0.1553E 03
   RC  4= 0.1596E 03   RC  5= 0.1640E 03   RC  6= 0.1686E 03
   RC  7= 0.1732E 03   RC

 FOPT  8= 0.1187E 01
   RC  1= 0.1013E 02   RC  2= 0.1471E 03   RC  3= 0.1511E 03
   RC  4= 0.1553E 03   RC  5= 0.1596E 03   RC  6= 0.1640E 03
   RC  7= 0.1686E 03   RC  8= 0.1732E 03   RC

 FOPT  9= 0.1209E 01
   RC  1= 0.1018E 02   RC  2= 0.1431E 03   RC  3= 0.1471E 03
   RC  4= 0.1511E 03   RC  5= 0.1553E 03   RC  6= 0.1596E 03
   RC  7= 0.1640E 03   RC  8= 0.1686E 03   RC  9= 0.1732E 03
   RC

 FOPT 10= 0.1232E 01
   RC  1= 0.1023E 02   RC  2= 0.1393E 03   RC  3= 0.1431E 03
   RC  4= 0.1471E 03   RC  5= 0.1511E 03   RC  6= 0.1553E 03
   RC  7= 0.1596E 03   RC  8= 0.1640E 03   RC  9= 0.1686E 03
   RC 10= 0.1732E 03   RC
```

theoretical optimum radius for the Mars A-Trajectory lay inside the planet surface, and, therefore, inside of the $1.1R_s$ inner range limit. The optimum radius for the Venus H-Trajectory lay outside the $6.1R_s$ outer limit, so an additional case with a larger range, $1.1R_s$ to $16.1R_s$, was also computed for comparison.

Additional information, which includes the correction radii grids and possible orbital radii, for each trajectory problem is contained in Appendix B, on pages 296-342. It is interesting to note that, as in previous results, sequence of corrections are nearly geometrically spaced in these results (see page 119).

Comparison of Optimal Sequence Processes

The comparison of the optimal sequence processes for fixed and variable orbits, which were discussed in this text, is difficult, for two reasons:

(1) the analysis for the fixed trajectory sequences, in Part I, assumed a constant error magnitude, while the variable-orbit sequence, in Part II, assumed an error equal to a constant percentage of the reference velocity magnitude, which varies with R;

(2) the square root of the sum of the squares of the errors was used in the first case, while an envelope of errors was used in the second.

To allow some means of comparison of the two sets of results, the following procedures were followed. First, errors of the same order of

magnitude were used in both problems. In the fixed-orbit case, an error of 0.00141 (29.8) was used. Since the initial velocity for the Mars H-Trajectory is 0.089(29.8)km/sec, the initial error is approximately 1.6% and the pericenter error is about 1.2% (corresponding to a pericenter velocity of 3.70 km/sec). Therefore, a 1.5% error was used throughout the variable-orbit problem.

To provide a basis for comparison of the error-envelope sum with the other error sum, an error distribution similar to a sinusoidal distribution was assumed, such that the root-mean square of the errors is .707 times the maximum error sum. The root-mean-square values for the inner and outer error analyses are then averaged, because it is assumed that they will be equally probably. This average is computed for the Mars H-Trajectory in Table XII, and compared to the results of Program 3 in Table XIV; however, the actual data from Program 3 is first converted in Table XIII to a percentage of increase over the theoretical optimum impulse. The n in Table represents the optimum number of corrections. There is poor correlation between the results of Programs 3 and 8 for fixed orbits; although they are the same order of magnitude, the values from Program 8 should be smaller. Two factors which may cause this discrepancy are: first, the majority of the corrections are made near orbit where the difference in assumed errors in the two programs is the greatest, and secondly, the radius grid of 100 is rather coarse and seemed to cause a deterimental effect on the accuracy of the approximations, which are inherent in the program. Due to time limitations this study could not be further developed. It would be desirable to decrease the

Table XII

Average Correction Impulses
for Program 8

	$\Delta V_{z\,OUT}$	$\Delta V_{z\,INN}$	$\Sigma \Delta V_z$	$\Sigma \Delta V_{z\,(rms)}$	$\Delta V_{z\,AVE}$
Mars H-Trajectory					
Fixed orbit	.188	.188	.376	.266	.133
Large init. error	.170	.183	.353	.250	.125
Small init. error	.143	.130	.273	.193	.097
Mars A-Trajectory	.173	.436	.609	.430	.215
Venus H-Trajectory					
1.1 to 6.1 range	.212	.239	.451	.319	.160
1.1 to 16.1 range	.049	.051	.100	.071	.035

Table XIII

Conversion of Program 3 Data

Mars H-Trajectory

ΔV^*	$.042/\Delta V^*$	ΔV_1	$\Delta V_1(.042/\Delta V^*)$
1.865	.0225	3.985	.0897

Table XIV

Comparison of Fixed and Variable Orbit
Correction Sequences

Mars H-Trajectory

Method of Analysis	ΔV	n
Fixed trajectory (Program 3)	.0897	6
Fixed orbit (Program 8)	.138	4
Range of orbits (Program 8) with large init. error (10%)	.125	2
Range of orbits (Program 8) with small init. error (1.5%)	.097	2

allowed error in Program 8, and increase the grid size, to obtain a better comparison to the two Programs. With some revisions to Program 8, it could be changed to assume the same constant error magnitude as Program 3, but the value of this is questionable, since the results of Program 8 are consistent among themselves, and indicate any savings in impulse would probably be small. It is reasonable that the fixed orbit case would require more impulse and a larger number or corrections than the variable orbit case. This is apparent from Table XIV, along with the fact that the larger error at the sphere of influence requires more impulse than the smaller error.

Table XV shows a comparison of cases with theoretical optimum radii within (Mars H) inside of (Mars A) and outside of the selected orbital range. (The reduction of the data to final form is shown in Table XII.) The two cases for which the optimum orbit is not within the range require higher corrective sums. A large reduction in corrective sum was achieved by increasing the allowable orbital range to include the theoretical optimum radius.

Table XV

Comparisons of Correction Sequences for Various

Trajectory Classes & Ranges of Orbits

Trajectory Class	Range	ΔV	n
Mars H	1.1-6.1	.097	2
Mars H	1.1-6.1	.215	2-8
Venus H	1.1-6.1	.160	2
Venus H	1.1-16.1	.035	2

Linear Perturbation Analysis

The results of Programs 9 and 10 are on page 135. These results confirm the fact that a 90° error angle or cross component of velocity error causes a maximum perturbation in orbital radius. The maximum perturbation in orbital-injection impulse is also very nearly 90° for small path angles near the sphere of influence. θ_v decreases for increasing path angles at both the sphere of influence and along the theoretical reference trajectory.

Solution Times

The solution times required for one individual case on the IBM 7090 computer are shown in Table XVI.

Table XVI

Solution Times

Method of Solution	Time per case
Fixed Trajectory	
Traenkle's Method	1 sec
Dynamic Programming (500-radii unif. grid)	4 min
Range of Orbits	
2-stage	10 sec
Dynamic Programming Sequence (100-radii geom. grid)	2 min

The table indicates that the simplified approach used by Dr. Traenkle requires a very small fraction of the time required by dynamic programming program. The time comparison indicates that the finer the radius grid for dynamic programming the more Solution time is required.

LINEAR PERTURBATION THEORY--THEOR.CPT.REF.TRAJ.

RIN= 0.326CE C3   VIN= 0.7424E 0C

	R/RS	THETA V (D)	THETA R (D)
1	0.3629E C1	-0.8942E C0	0.7131E 02
2	0.4598E C1	0.3121E C2	0.81C6E 02
3	0.5826E C1	0.4427E C2	0.7978E 02
4	0.7382E C1	0.5363E C2	0.7999E C2
5	C.9354E C1	0.6088E C2	0.8C81E 02
6	C.1185E C2	0.6664E C2	0.8186E 02
7	C.1502E C2	0.7127E C2	C.8298E 02
8	C.1903E C2	0.75CCE C2	C.84C6E C2
9	C.2411E C2	C.78C1E C2	C.8504E C2
10	0.3055E C2	0.8043E C2	C.8591E 02
11	0.3872E C2	C.8238E C2	C.8665E C2
12	0.4906E C2	C.8394E C2	0.8728E C2
13	0.6216E C2	0.8519E C2	C.8781E 02
14	0.7877E C2	0.8618E C2	C.8824E 02
15	0.998CE C2	0.8697E C2	0.8859E 02
16	0.1265E C3	0.876CE C2	0.8887E C2
17	0.16C2E C3	C.881CE C2	C.891CE 02
18	0.2030E C3	C.885CE C2	0.8929E 02
19	0.2573E 03	0.8881E C2	0.8943E C2
20	0.326CE C3	C.8906E C2	C.8955E C2

LINEAR PERTURBATION THEORY--AT SPHERE OF INFLUENCE

RIN= 0.3260E C3   VIN= 0.8900E-01   G= C.1080E-00   RS= 0.5

	FI(D)	THETA V (D)	THETA R (D)
1	0.100CE-0C	0.899CE 02	0.899CE 02
2	0.200CE-00	0.8980E 02	0.8982E 02
3	0.3000E-00	0.8967E 02	0.8975E 02
4	0.400CE-00	0.8942E 02	0.8969E C2
5	0.5000E-0C	0.8685E 02	0.8965E C2
6	0.600CE 0C	0.8762E 02	0.8962E C2
7	0.7000E 00	0.8494E 02	0.8959E 02
8	0.8000E 0C	0.7881E 02	0.8957E C2
9	0.900CE 00	0.6292E 02	0.8955E 02
10	1.0000E 00	0.2128E 02	0.8954E 02
11	0.1100E 01	0.1579E 03	0.8953E 02
12	0.120CE 01	0.1412E 03	0.8952E C2
13	0.130CE 01	0.1354E 03	0.8951E 02
14	0.1400E 01	0.1334E 03	0.8950E 02
15	0.1500F 01	0.1332E 03	0.8949F C2
16	0.16CCE 01	0.1340E 03	0.8949E C2
17	0.170CE 01	0.1352E 03	0.8948E 02
18	0.1800E 01	0.1367E 03	0.8949E 02
19	0.190CE 01	0.1384E 03	0.8947E 02
20	0.2000E 01	0.1402E 03	0.8947E 02

General Conclusions

One of the most significant results of the studies in this thesis is the confirmation that a geometrical spacing of corrections is an optimum configuration. Separate studies have also confirmed the fact that cross components of error velocity have the greatest effect on the orbital radius. Also, for small errors on the order of 1% of the velocity magnitude, the total impulse sum is a small percent of the Basic Velocity Sum, in all cases it was less than 5%. Some savings can be made by correcting to a fixed orbit rather than fixed trajectory, and an additional saving can be obtained by allowing a range of orbits rather than correcting to a predetermined radius. But these savings are a very small percentages of the Basic Velocity Sum for small errors. Unless the amount of fuel is very critical or the errors encountered are very large, the savings in fuel expended may not offset the additional time and complexity of the calculations for the orbital range.

Bibliography

1. Bellman, and S. E. Dreyfus. Applied Dynamic Programming. Princeton, New Jersey: Princeton University Press, 1962. Rand Report 352-PR.

2. Traenkle, C. A. Problems of the Mechanics of Interplanetery Space Travel. ARL Technical Report, ARL-141. Wright-Patterson AFB, Ohio: Aeronautical Research Laboratory, Nov. 1961.

3. Traenkle, C. A. Basic Reflection Trajectories for Interplanetary Space Travel. TR-37. Wright-Patterson AFB, Ohio: Institute of Technology, April 1962.

4. Traenkle, C. A. Basic Mechanics and Astrodynamics. TR-39. Wright-Patterson AFB, Ohio: Institute of Technology, Jan. 1963.

5. Traenkle, C. A. Midcourse Navigation, Exemplified by the Hohmann Transfer Earth-Mars. TR-42 (preliminary). Wright-Patterson AFB, Ohio: Institute of Technology, March 1963.

Appendix A

Program 1

(Sphere of Influence Entry Error Analysis)

```
GRH  TWO-STEP, VARIABLE COLLISION ANGLE PROBLEM

      DIMENSION FI(19),TITLE(12),TITLE2(12)
      DUAL=0.0
      FI(1)=1.57079633
C    WRITE THE VARIABLE ANGLE CONDITIONS
      DO 4 I=2,19
 4    FI(I)=FI(I-1)-0.17453293
 10   READ INPUT TAPE 2,201,TITLE,G,RIN,RPLAN
 201  FORMAT (12A6,/3E12.0)
      RIN=RIN*RPLAN
 11   READ INPUT TAPE 2,202,VIN,TITLE2
 202  FORMAT (E12.0,/12A6)
C    COMPUTE OPTIMAL PARAMETERS
      VIN=VIN*29.8
      VIN2=VIN*VIN
      EO=VIN2/2.0-G/RIN
      VINFN=SQRTF(2.0*EO)
      RO=2.0*G/(VINFN**2)
      IF(RO-1.1*RPLAN)2,3,3
 2    RO=1.1*RPLAN
 3    AO=G/(2.0*EO)
      ECCO=(RO/AO)+1.0
      BO=AO*SQRTF((ECCO*ECCO)-1.0)
      FIO=ASIN(BO/RIN)
      VCO=SQRTF(G/RO)
      VOP=SQRTF(G*(2.0/RO+1.0/AO))
      DVC=VOP-VCO
      DVCN=DVC/29.8
      RON=RO/RPLAN
      WRITE OUTPUT TAPE 3,301,TITLE,TITLE2,DVCN,RON
  301 FORMAT (1H1,12A6,/12A6,/10X,5HDVCN=E12.5,
     15X,4HRON=E12.5)
C    COMPUTE THE VELOCITY CORRECTIONS
      DO 5 I=1,19
      H=RIN*VIN*SINF(FI(I))
      B=SQRTF((H*H)/(2.0*EO))
      BR=B/BO
      DFI=ABSF(FIO-FI(I))
      DV=SQRTF(2.0*VIN2*(1.0-COSF(DFI)))
      DVN=(DV/DVC)*100.0
    5 WRITE OUTPUT TAPE 3,302,BR,DVN,FI(I)
  302 FORMAT (10X,3HBR=E10.4,4X,3HDV=E12.5,4X,6HFI(I)=E11.4)
      DUAL=DUAL+1.0
      IF(DUAL-4.0)11,10,11
      END(1,0,0,0,0,0,1,0,0,1,0,0,0,0,0)
```

```
TWO-STEP, VARIABLE COLLISION ANGLE PROBLEM---VENUS
CLASS     F
DVCN= 0.62945E-01      RON= 0.14958E 02
BR=0.8075E 01      DV= 0.19496E 03     FI(I)= 0.1571E 01
BR=0.7952E 01      DV= 0.17487E 03     FI(I)= 0.1396E 01
BR=0.7588E 01      DV= 0.15344E 03     FI(I)= 0.1222E 01
BR=0.6993E 01      DV= 0.13085E 03     FI(I)= 0.1047E 01
BR=0.6186E 01      DV= 0.10726E 03     FI(I)= 0.8727E 00
BR=0.5190E 01      DV= 0.82852E 02     FI(I)= 0.6981E 00
BR=0.4037E 01      DV= 0.57816E 02     FI(I)= 0.5236E 00
BR=0.2762E 01      DV= 0.32339E 02     FI(I)= 0.3491E-00
BR=0.1402E 01      DV= 0.66164E 01     FI(I)= 0.1745E-00
BR=0.6016E-06      DV= 0.19157E 02     FI(I)=-0.7451E-07
BR=0.1402E 01      DV= 0.44784E 02     FI(I)=-0.1745E-00
BR=0.2762E 01      DV= 0.70070E 02     FI(I)=-0.3491E-00
BR=0.4037E 01      DV= 0.94824E 02     FI(I)=-0.5236E 00
BR=0.5190E 01      DV= 0.11886E 03     FI(I)=-0.6981E 00
BR=0.6186E 01      DV= 0.14198E 03     FI(I)=-0.8727E 00
BR=0.6993E 01      DV= 0.16403E 03     FI(I)=-0.1047E 01
BR=0.7588E 01      DV= 0.18483E 03     FI(I)=-0.1222E 01
BR=0.7952E 01      DV= 0.20422E 03     FI(I)=-0.1396E 01
BR=0.8075E 01      DV= 0.22205E 03     FI(I)=-0.1571E 01
```

```
TWO-STEP, VARIABLE COLLISION ANGLE PROBLEM---VENUS
CLASS     F
DVCN= 0.62945E-01      RON= 0.14958E 02
BR=0.1402E 01      DV= 0.66164E 01     FI(I)= 0.1745E-00
BR=0.1263E 01      DV= 0.40382E 01     FI(I)= 0.1571E-00
BR=0.1124E 01      DV= 0.14597E 01     FI(I)= 0.1396E-00
BR=0.9841E 00      DV= 0.11192E 01     FI(I)= 0.1222E-00
BR=0.8440E 00      DV= 0.36978E 01     FI(I)= 0.1047E-00
BR=0.7038E 00      DV= 0.62761E 01     FI(I)= 0.8727E-01
BR=0.5633E 00      DV= 0.88539E 01     FI(I)= 0.6981E-01
BR=0.4226E-00      DV= 0.11431E 02     FI(I)= 0.5236E-01
BR=0.2818E-00      DV= 0.14007E 02     FI(I)= 0.3491E-01
BR=0.1409E-00      DV= 0.16583E 02     FI(I)= 0.1745E-01
BR=0.6016E-07      DV= 0.19157E 02     FI(I)=-0.7451E-08
BR=0.1409E-00      DV= 0.21729E 02     FI(I)=-0.1745E-01
BR=0.2818E-00      DV= 0.24300E 02     FI(I)=-0.3491E-01
BR=0.4226E-00      DV= 0.26869E 02     FI(I)=-0.5236E-01
BR=0.5633E 00      DV= 0.29436E 02     FI(I)=-0.6981E-01
BR=0.7038E 00      DV= 0.32001E 02     FI(I)=-0.8727E-01
BR=0.8440E 00      DV= 0.34563E 02     FI(I)=-0.1047E-00
BR=0.9841E 00      DV= 0.37123E 02     FI(I)=-0.1222E-00
BR=0.1124E 01      DV= 0.39680E 02     FI(I)=-0.1396E-00
```

```
TWO-STEP, VARIABLE COLLISION ANGLE PROBLEM---VENUS
CLASS      A
DVCN= 0.16650E-00       RON= 0.21378E 01
BR=0.5443E 02     DV= 0.19943E 03     FI(I)= 0.1571E 01
BR=0.5360E 02     DV= 0.18097E 03     FI(I)= 0.1396E 01
BR=0.5115E 02     DV= 0.16113E 03     FI(I)= 0.1222E 01
BR=0.4714E 02     DV= 0.14006E 03     FI(I)= 0.1047E 01
BR=0.4170E 02     DV= 0.11792E 03     FI(I)= 0.8727E 00
BR=0.3499E 02     DV= 0.94891E 02     FI(I)= 0.6981E 00
BR=0.2722E 02     DV= 0.71136E 02     FI(I)= 0.5236E 00
BR=0.1862E 02     DV= 0.46841E 02     FI(I)= 0.3491E-00
BR=0.9452E 01     DV= 0.22189E 02     FI(I)= 0.1745E-00
BR=0.4055E-05     DV= 0.26323E 01     FI(I)=-0.7451E-07
BR=0.9452E 01     DV= 0.27433E 02     FI(I)=-0.1745E-00
BR=0.1862E 02     DV= 0.52025E 02     FI(I)=-0.3491E-00
BR=0.2722E 02     DV= 0.76222E 02     FI(I)=-0.5236E 00
BR=0.3499E 02     DV= 0.99838E 02     FI(I)=-0.6981E 00
BR=0.4170E 02     DV= 0.12269E 03     FI(I)=-0.8727E 00
BR=0.4714E 02     DV= 0.14462E 03     FI(I)=-0.1047E 01
BR=0.5115E 02     DV= 0.16544E 03     FI(I)=-0.1222E 01
BR=0.5360E 02     DV= 0.18500E 03     FI(I)=-0.1396E 01
BR=0.5443E 02     DV= 0.20316E 03     FI(I)=-0.1571E 01

TWO-STEP, VARIABLE COLLISION ANGLE PROBLEM---VENUS
CLASS      A
DVCN= 0.16650E-00       RON= 0.21378E 01
BR=0.9452E 01     DV= 0.22189E 02     FI(I)= 0.1745E-00
BR=0.8515E 01     DV= 0.19711E 02     FI(I)= 0.1571E-00
BR=0.7575E 01     DV= 0.17232E 02     FI(I)= 0.1396E-00
BR=0.6634E 01     DV= 0.14752E 02     FI(I)= 0.1222E-00
BR=0.5690E 01     DV= 0.12270E 02     FI(I)= 0.1047E-00
BR=0.4744E 01     DV= 0.97876E 01     FI(I)= 0.8727E-01
BR=0.3797E 01     DV= 0.73043E 01     FI(I)= 0.6981E-01
BR=0.2849E 01     DV= 0.48206E 01     FI(I)= 0.5236E-01
BR=0.1900E 01     DV= 0.23365E 01     FI(I)= 0.3491E-01
BR=0.9500E 00     DV= 0.14846E-00     FI(I)= 0.1745E-01
BR=0.4055E-06     DV= 0.26323E 01     FI(I)=-0.7451E-08
BR=0.9500E 00     DV= 0.51164E 01     FI(I)=-0.1745E-01
BR=0.1900E 01     DV= 0.76001E 01     FI(I)=-0.3491E-01
BR=0.2849E 01     DV= 0.10083E 02     FI(I)=-0.5236E-01
BR=0.3797E 01     DV= 0.12566E 02     FI(I)=-0.6981E-01
BR=0.4744E 01     DV= 0.15047E 02     FI(I)=-0.8727E-01
BR=0.5690E 01     DV= 0.17527E 02     FI(I)=-0.1047E-00
BR=0.6634E 01     DV= 0.20006E 02     FI(I)=-0.1222E-00
BR=0.7575E 01     DV= 0.22484E 02     FI(I)=-0.1396E-00
```

```
TWC-STEP, VARIABLE COLLISICN ANGLE PROBLEM---VENUS
CLASS     C
DVCN= 0.31859E-00      RCN= C.110COE 01
BR=0.1196E C3     DV= C.19582E C3     FI(I)= C.1571E C1
BR=0.1177E C3     DV= C.17786E C3     FI(I)= C.1396E C1
BR=0.1124E 03     DV= 0.15855E C3     FI(I)= C.1222E C1
BR=C.1035E 03     DV= 0.13804E C3     FI(I)= C.1047E C1
BR=0.9159E 02     DV= 0.11647E C3     FI(I)= 0.8727E 00
BR=0.7686E 02     DV= 0.94020E C2     FI(I)= C.6981E 00
BR=0.5978E C2     DV= 0.70851E C2     FI(I)= C.5236E CC
BR=0.4089E C2     DV= 0.47143E C2     FI(I)= C.3491E-CC
BR=C.2076E 02     DV= 0.23077E C2     FI(I)= C.1745E-CC
BR=0.8908E-C5     DV= 0.11653E C1     FI(I)=-0.7451E-07
BR=0.2076E 02     DV= 0.25398E C2     FI(I)=-C.1745E-C0
BR=C.4089E C2     DV= C.49438E C2     FI(I)=-C.3491E-0C
BR=0.5978E C2     DV= 0.73102E 02     FI(I)=-C.5236E 00
BR=C.7686E 02     DV= 0.96209E C2     FI(I)=-0.6981E CC
BR=0.9159E 02     DV= 0.11858E C3     FI(I)=-C.8727E CC
BR=C.1035E C3     DV= C.14006E C3     FI(I)=-C.1047E C1
BR=0.1124E C3     DV= C.16046E C3     FI(I)=-C.1222E C1
BR=0.1177E C3     DV= 0.17965E C3     FI(I)=-0.1396E 01
BR=0.1196E 03     DV= 0.19747E C3     FI(I)=-C.1571E C1

TWC-STEP, VARIABLE COLLISICN ANGLE PROBLEM---VENUS
CLASS     C
DVCN= 0.31859E-00      RCN= C.110COE 01
BR=0.2076E 02     DV= C.23077E C2     FI(I)= 0.1745E-CC
BR=0.1870E 02     CV= C.20658E C2     FI(I)= C.1571E-CC
BR=0.1664E C2     DV= 0.18237E C2     FI(I)= C.1396E-CC
BR=0.1457E C2     DV= 0.15814E C2     FI(I)= C.1222E-CC
BR=0.1250E 02     DV= 0.13391E C2     FI(I)= C.1047E-CC
BR=0.1042E 02     DV= C.10966E C2     FI(I)= C.8727E-C1
BR=0.8341E C1     DV= C.85410E C1     FI(I)= C.6981E-C1
BR=0.6258E C1     DV= 0.61150E C1     FI(I)= C.5236E-C1
BR=0.4173E C1     DV= 0.36885E C1     FI(I)= C.3491E-C1
BR=C.2087E C1     DV= 0.12618E C1     FI(I)= C.1745E-C1
BR=C.8908E-06     DV= 0.11651E 01     FI(I)=-C.7451E-C8
BR=0.2087E C1     DV= 0.35919E C1     FI(I)=-C.1745E-C1
BR=0.4173E 01     DV= 0.60184E C1     FI(I)=-C.3491E-C1
BR=C.6258E C1     DV= C.84444E C1     FI(I)=-C.5236E-C1
BR=0.8341E 01     DV= 0.10870E C2     FI(I)=-C.6981E-01
BR=0.1042E 02     DV= 0.13294E C2     FI(I)=-C.8727E-C1
BR=0.1250E C2     DV= 0.15718E C2     FI(I)=-C.1047E-CC
BR=0.1457E C2     DV= 0.18140E C2     FI(I)=-C.1222E-CC
BR=0.1664E 02     DV= 0.20561E C2     FI(I)=-C.1396E-00
```

```
TWO-STEP, VARIABLE COLLISION ANGLE PROBLEM---VENUS
CLASS     D
DVCN= 0.87761E-01      RON= 0.76948E 01
BR=0.1537E 02      DV= 0.19772E 03      FI(I)= 0.1571E 01
BR=0.1514E 02      DV= 0.17855E 03      FI(I)= 0.1396E 01
BR=0.1445E 02      DV= 0.15802E 03      FI(I)= 0.1222E 01
BR=0.1331E 02      DV= 0.13628E 03      FI(I)= 0.1047E 01
BR=0.1178E 02      DV= 0.11351E 03      FI(I)= 0.8727E 00
BR=0.9882E 01      DV= 0.89878E 02      FI(I)= 0.6981E 00
BR=0.7687E 01      DV= 0.65558E 02      FI(I)= 0.5236E 00
BR=0.5258E 01      DV= 0.40739E 02      FI(I)= 0.3491E-00
BR=0.2670E 01      DV= 0.15611E 02      FI(I)= 0.1745E-00
BR=0.1145E-05      DV= 0.96369E 01      FI(I)=-0.7451E-07
BR=0.2670E 01      DV= 0.34811E 02      FI(I)=-0.1745E-00
BR=0.5258E 01      DV= 0.59720E 02      FI(I)=-0.3491E-00
BR=0.7687E 01      DV= 0.84175E 02      FI(I)=-0.5236E 00
BR=0.9882E 01      DV= 0.10799E 03      FI(I)=-0.6981E 00
BR=0.1178E 02      DV= 0.13098E 03      FI(I)=-0.8727E 00
BR=0.1331E 02      DV= 0.15298E 03      FI(I)=-0.1047E 01
BR=0.1445E 02      DV= 0.17381E 03      FI(I)=-0.1222E 01
BR=0.1514E 02      DV= 0.19332E 03      FI(I)=-0.1396E 01
BR=0.1537E 02      DV= 0.21135E 03      FI(I)=-0.1571E 01

TWO-STEP, VARIABLE COLLISION ANGLE PROBLEM---VENUS
CLASS     D
DVCN= 0.87761E-01      RON= 0.76948E 01
BR=0.2670E 01      DV= 0.15611E 02      FI(I)= 0.1745E-00
BR=0.2405E 01      DV= 0.13088E 02      FI(I)= 0.1571E-00
BR=0.2140E 01      DV= 0.10565E 02      FI(I)= 0.1396E-00
BR=0.1874E 01      DV= 0.80401E 01      FI(I)= 0.1222E-00
BR=0.1607E 01      DV= 0.55152E 01      FI(I)= 0.1047E-00
BR=0.1340E 01      DV= 0.29898E 01      FI(I)= 0.8727E-01
BR=0.1072E 01      DV= 0.46436E-00      FI(I)= 0.6981E-01
BR=0.8046E 00      DV= 0.20616E 01      FI(I)= 0.5236E-01
BR=0.5366E 00      DV= 0.45871E 01      FI(I)= 0.3491E-01
BR=0.2683E-00      DV= 0.71122E 01      FI(I)= 0.1745E-01
BR=0.1145E-06      DV= 0.96369E 01      FI(I)=-0.7451E-08
BR=0.2683E-00      DV= 0.12161E 02      FI(I)=-0.1745E-01
BR=0.5366E 00      DV= 0.14684E 02      FI(I)=-0.3491E-01
BR=0.8046E 00      DV= 0.17206E 02      FI(I)=-0.5236E-01
BR=0.1072E 01      DV= 0.19726E 02      FI(I)=-0.6981E-01
BR=0.1340E 01      DV= 0.22245E 02      FI(I)=-0.8727E-01
BR=0.1607E 01      DV= 0.24762E 02      FI(I)=-0.1047E-00
BR=0.1874E 01      DV= 0.27278E 02      FI(I)=-0.1222E-00
BR=0.2140E 01      DV= 0.29791E 02      FI(I)=-0.1396E-00
```

```
TWO-STEP, VARIABLE COLLISION ANGLE PROBLEM---MARS
CLASS      H
DVCN= 0.62576E-01       RON= 0.36714E 01
BR=0.6220E 02     DV= 0.19951E 03     FI(I)= 0.1571E 01
BR=0.6125E 02     DV= 0.18108E 03     FI(I)= 0.1396E 01
BR=0.5845E 02     DV= 0.16127E 03     FI(I)= 0.1222E 01
BR=0.5386E 02     DV= 0.14023E 03     FI(I)= 0.1047E 01
BR=0.4765E 02     DV= 0.11813E 03     FI(I)= 0.8727E 00
BR=0.3998E 02     DV= 0.95125E 02     FI(I)= 0.6981E 00
BR=0.3110E 02     DV= 0.71398E 02     FI(I)= 0.5236E 00
BR=0.2127E 02     DV= 0.47129E 02     FI(I)= 0.3491E-00
BR=0.1080E 02     DV= 0.22500E 02     FI(I)= 0.1745E-00
BR=0.4634E-05     DV= 0.23000E 01     FI(I)=-0.7451E-07
BR=0.1080E 02     DV= 0.27082E 02     FI(I)=-0.1745E-00
BR=0.2127E 02     DV= 0.51658E 02     FI(I)=-0.3491E-00
BR=0.3110E 02     DV= 0.75841E 02     FI(I)=-0.5236E 00
BR=0.3998E 02     DV= 0.99447E 02     FI(I)=-0.6981E 00
BR=0.4765E 02     DV= 0.12230E 03     FI(I)=-0.8727E 00
BR=0.5386E 02     DV= 0.14421E 03     FI(I)=-0.1047E 01
BR=0.5845E 02     DV= 0.16504E 03     FI(I)=-0.1222E 01
BR=0.6125E 02     DV= 0.18460E 03     FI(I)=-0.1396E 01
BR=0.6220E 02     DV= 0.20276E 03     FI(I)=-0.1571E 01
```

```
TWO-STEP, VARIABLE COLLISION ANGLE PROBLEM---MARS
CLASS      H
DVCN= 0.62576E-01       RON= 0.36714E 01
BR=0.1080E 02     DV= 0.22500E 02     FI(I)= 0.1745E-00
BR=0.9730E 01     DV= 0.20025E 02     FI(I)= 0.1571E-00
BR=0.8656E 01     DV= 0.17548E 02     FI(I)= 0.1396E-00
BR=0.7580E 01     DV= 0.15069E 02     FI(I)= 0.1222E-00
BR=0.6501E 01     DV= 0.12590E 02     FI(I)= 0.1047E-00
BR=0.5421E 01     DV= 0.10110E 02     FI(I)= 0.8727E-01
BR=0.4339E 01     DV= 0.76286E 01     FI(I)= 0.6981E-01
BR=0.3255E 01     DV= 0.51468E 01     FI(I)= 0.5236E-01
BR=0.2171E 01     DV= 0.26648E 01     FI(I)= 0.3491E-01
BR=0.1085E 01     DV= 0.18292E-00     FI(I)= 0.1745E-01
BR=0.4634E-06     DV= 0.22999E 01     FI(I)=-0.7451E-08
BR=0.1085E 01     DV= 0.47820E 01     FI(I)=-0.1745E-01
BR=0.2171E 01     DV= 0.72638E 01     FI(I)=-0.3491E-01
BR=0.3255E 01     DV= 0.97450E 01     FI(I)=-0.5236E-01
BR=0.4339E 01     DV= 0.12225E 02     FI(I)=-0.6981E-01
BR=0.5421E 01     DV= 0.14705E 02     FI(I)=-0.8727E-01
BR=0.6501E 01     DV= 0.17183E 02     FI(I)=-0.1047E-00
BR=0.7580E 01     DV= 0.19661E 02     FI(I)=-0.1222E-00
BR=0.8656E 01     DV= 0.22136E 02     FI(I)=-0.1396E-00
```

```
TWO-STEP, VARIABLE COLLISION ANGLE PROBLEM---MARS
CLASS      A
DVCN= 0.16584E-00      RON= 0.11000E 01
BR=0.2386E 03      DV= 0.19487E 03      FI(I)= 0.1571E 01
BR=0.2350E 03      DV= 0.17707E 03      FI(I)= 0.1396E 01
BR=0.2242E 03      DV= 0.15793E 03      FI(I)= 0.1222E 01
BR=0.2066E 03      DV= 0.13758E 03      FI(I)= 0.1047E 01
BR=0.1828E 03      DV= 0.11619E 03      FI(I)= 0.8727E 00
BR=0.1534E 03      DV= 0.93911E 02      FI(I)= 0.6981E 00
BR=0.1193E 03      DV= 0.70918E 02      FI(I)= 0.5236E 00
BR=0.8161E 02      DV= 0.47386E 02      FI(I)= 0.3491E-00
BR=0.4143E 02      DV= 0.23493E 02      FI(I)= 0.1745E-00
BR=0.1778E-04      DV= 0.57952E 00      FI(I)=-0.7451E-07
BR=0.4143E 02      DV= 0.24647E 02      FI(I)=-0.1745E-00
BR=0.8161E 02      DV= 0.48527E 02      FI(I)=-0.3491E-00
BR=0.1193E 03      DV= 0.72037E 02      FI(I)=-0.5236E 00
BR=0.1534E 03      DV= 0.95000E 02      FI(I)=-0.6981E 00
BR=0.1828E 03      DV= 0.11724E 03      FI(I)=-0.8727E 00
BR=0.2066E 03      DV= 0.13859E 03      FI(I)=-0.1047E 01
BR=0.2242E 03      DV= 0.15888E 03      FI(I)=-0.1222E 01
BR=0.2350E 03      DV= 0.17796E 03      FI(I)=-0.1396E 01
BR=0.2386E 03      DV= 0.19569E 03      FI(I)=-0.1571E 01
```

```
TWO-STEP, VARIABLE COLLISION ANGLE PROBLEM---MARS
CLASS      A
DVCN= 0.16584E-00      RON= 0.11000E 01
BR=0.4143E 02      DV= 0.23493E 02      FI(I)= 0.1745E-00
BR=0.3733E 02      DV= 0.21091E 02      FI(I)= 0.1571E-00
BR=0.3321E 02      DV= 0.18687E 02      FI(I)= 0.1396E-00
BR=0.2908E 02      DV= 0.16282E 02      FI(I)= 0.1222E-00
BR=0.2494E 02      DV= 0.13875E 02      FI(I)= 0.1047E-00
BR=0.2080E 02      DV= 0.11468E 02      FI(I)= 0.8727E-01
BR=0.1664E 02      DV= 0.90593E 01      FI(I)= 0.6981E-01
BR=0.1249E 02      DV= 0.66503E 01      FI(I)= 0.5236E-01
BR=0.8327E 01      DV= 0.42407E 01      FI(I)= 0.3491E-01
BR=0.4164E 01      DV= 0.18309E 01      FI(I)= 0.1745E-01
BR=0.1778E-05      DV= 0.57927E 00      FI(I)=-0.7451E-08
BR=0.4164E 01      DV= 0.29892E 01      FI(I)=-0.1745E-01
BR=0.8327E 01      DV= 0.53990E 01      FI(I)=-0.3491E-01
BR=0.1249E 02      DV= 0.78083E 01      FI(I)=-0.5236E-01
BR=0.1664E 02      DV= 0.10217E 02      FI(I)=-0.6981E-01
BR=0.2080E 02      DV= 0.12625E 02      FI(I)=-0.8727E-01
BR=0.2494E 02      DV= 0.15032E 02      FI(I)=-0.1047E-00
BR=0.2908E 02      DV= 0.17438E 02      FI(I)=-0.1222E-00
BR=0.3321E 02      DV= 0.19842E 02      FI(I)=-0.1396E-00
```

```
TWO-STEP, VARIABLE COLLISION ANGLE PROBLEM---MARS
CLASS      B
DVCN= 0.26024E-00      RON= 0.11000E 01
BR=0.2634E 03     DV= 0.18333E 03     FI(I)= 0.1571E 01
BR=0.2594E 03     DV= 0.16659E 03     FI(I)= 0.1396E 01
BR=0.2475E 03     DV= 0.14859E 03     FI(I)= 0.1222E 01
BR=0.2281E 03     DV= 0.12945E 03     FI(I)= 0.1047E 01
BR=0.2018E 03     DV= 0.10933E 03     FI(I)= 0.8727E 00
BR=0.1693E 03     DV= 0.88381E 02     FI(I)= 0.6981E 00
BR=0.1317E 03     DV= 0.66755E 02     FI(I)= 0.5236E 00
BR=0.9009E 02     DV= 0.44622E 02     FI(I)= 0.3491E-00
BR=0.4574E 02     DV= 0.22148E 02     FI(I)= 0.1745E-00
BR=0.1963E-04     DV= 0.49354E-00     FI(I)=-0.7451E-07
BR=0.4574E 02     DV= 0.23131E 02     FI(I)=-0.1745E-00
BR=0.9009E 02     DV= 0.45593E 02     FI(I)=-0.3491E-00
BR=0.1317E 03     DV= 0.67708E 02     FI(I)=-0.5236E 00
BR=0.1693E 03     DV= 0.89308E 02     FI(I)=-0.6981E 00
BR=0.2018E 03     DV= 0.11023E 03     FI(I)=-0.8727E 00
BR=0.2281E 03     DV= 0.13031E 03     FI(I)=-0.1047E 01
BR=0.2475E 03     DV= 0.14940E 03     FI(I)=-0.1222E 01
BR=0.2594E 03     DV= 0.16735E 03     FI(I)=-0.1396E 01
BR=0.2634E 03     DV= 0.18403E 03     FI(I)=-0.1571E 01
```

```
TWO-STEP, VARIABLE COLLISION ANGLE PROBLEM---MARS
CLASS      B
DVCN= 0.26024E-00      RON= 0.11000E 01
BR=0.4574E 02     DV= 0.22149E 02     FI(I)= 0.1745E-00
BR=0.4121E 02     DV= 0.19889E 02     FI(I)= 0.1571E-00
BR=0.3666E 02     DV= 0.17628E 02     FI(I)= 0.1396E-00
BR=0.3210E 02     DV= 0.15366E 02     FI(I)= 0.1222E-00
BR=0.2753E 02     DV= 0.13102E 02     FI(I)= 0.1047E-00
BR=0.2296E 02     DV= 0.10838E 02     FI(I)= 0.8727E-01
BR=0.1838E 02     DV= 0.85727E 01     FI(I)= 0.6981E-01
BR=0.1379E 02     DV= 0.63067E 01     FI(I)= 0.5236E-01
BR=0.9193E 01     DV= 0.40403E 01     FI(I)= 0.3491E-01
BR=0.4597E 01     DV= 0.17736E 01     FI(I)= 0.1745E-01
BR=0.1963E-05     DV= 0.49354E-00     FI(I)=-0.7451E-08
BR=0.4597E 01     DV= 0.27601E 01     FI(I)=-0.1745E-01
BR=0.9193E 01     DV= 0.50267E 01     FI(I)=-0.3491E-01
BR=0.1379E 02     DV= 0.72929E 01     FI(I)=-0.5236E-01
BR=0.1838E 02     DV= 0.95586E 01     FI(I)=-0.6981E-01
BR=0.2296E 02     DV= 0.11824E 02     FI(I)=-0.8727E-01
BR=0.2753E 02     DV= 0.14088E 02     FI(I)=-0.1047E-00
BR=0.3210E 02     DV= 0.16351E 02     FI(I)=-0.1222E-00
BR=0.3666E 02     DV= 0.18612E 02     FI(I)=-0.1396E-00
```

```
TWO-STEP, VARIABLE COLLISION ANGLE PROBLEM---MARS
CLASS     C
DVCN= 0.51184E 00      RON= 0.11000E 01
BR=0.2820E 03      DV= 0.16687E 03      FI(I)= 0.1571E 01
BR=0.2778E 03      DV= 0.15164E 03      FI(I)= 0.1396E 01
BR=0.2650E 03      DV= 0.13525E 03      FI(I)= 0.1222E 01
BR=0.2443E 03      DV= 0.11784E 03      FI(I)= 0.1047E 01
BR=0.2161E 03      DV= 0.99528E 02      FI(I)= 0.8727E 00
BR=0.1813E 03      DV= 0.80461E 02      FI(I)= 0.6981E 00
BR=0.1410E 03      DV= 0.60781E 02      FI(I)= 0.5236E 00
BR=0.9647E 02      DV= 0.40638E 02      FI(I)= 0.3491E-00
BR=0.4898E 02      DV= 0.20186E 02      FI(I)= 0.1745E-00
BR=0.2101E-04      DV= 0.41943E-00      FI(I)=-0.7451E-07
BR=0.4898E 02      DV= 0.21021E 02      FI(I)=-0.1745E-00
BR=0.9647E 02      DV= 0.41464E 02      FI(I)=-0.3491E-00
BR=0.1410E 03      DV= 0.61590E 02      FI(I)=-0.5236E 00
BR=0.1813E 03      DV= 0.81248E 02      FI(I)=-0.6981E 00
BR=0.2161E 03      DV= 0.10029E 03      FI(I)=-0.8727E 00
BR=0.2443E 03      DV= 0.11856E 03      FI(I)=-0.1047E 01
BR=0.2650E 03      DV= 0.13594E 03      FI(I)=-0.1222E 01
BR=0.2778E 03      DV= 0.15228E 03      FI(I)=-0.1396E 01
BR=0.2820E 03      DV= 0.16746E 03      FI(I)=-0.1571E 01
```

```
TWO-STEP, VARIABLE COLLISION ANGLE PROBLEM---MARS
CLASS     C
DVCN= 0.51184E 00      RON= 0.11000E 01
BR=0.4898E 02      DV= 0.20186E 02      FI(I)= 0.1745E-00
BR=0.4412E 02      DV= 0.18130E 02      FI(I)= 0.1571E-00
BR=0.3925E 02      DV= 0.16073E 02      FI(I)= 0.1396E-00
BR=0.3437E 02      DV= 0.14014E 02      FI(I)= 0.1222E-00
BR=0.2948E 02      DV= 0.11954E 02      FI(I)= 0.1047E-00
BR=0.2458E 02      DV= 0.98930E 01      FI(I)= 0.8727E-01
BR=0.1967E 02      DV= 0.78315E 01      FI(I)= 0.6981E-01
BR=0.1476E 02      DV= 0.57693E 01      FI(I)= 0.5236E-01
BR=0.9843E 01      DV= 0.37067E 01      FI(I)= 0.3491E-01
BR=0.4922E 01      DV= 0.16439E 01      FI(I)= 0.1745E-01
BR=0.2101E-05      DV= 0.41943E-00      FI(I)=-0.7451E-08
BR=0.4922E 01      DV= 0.24821E 01      FI(I)=-0.1745E-01
BR=0.9843E 01      DV= 0.45449E 01      FI(I)=-0.3491E-01
BR=0.1476E 02      DV= 0.66073E 01      FI(I)=-0.5236E-01
BR=0.1967E 02      DV= 0.86692E 01      FI(I)=-0.6981E-01
BR=0.2458E 02      DV= 0.10730E 02      FI(I)=-0.8727E-01
BR=0.2948E 02      DV= 0.12791E 02      FI(I)=-0.1047E-00
BR=0.3437E 02      DV= 0.14850E 02      FI(I)=-0.1222E-00
BR=0.3925E 02      DV= 0.16909E 02      FI(I)=-0.1396E-00
```

Program 2

(Longitudinal and Transverse Error Velocity Analysis)

(Constant Magnitude Corrective Impulse Error Analysis)

(Time to Pericenter)

OK

```
GRH COMPARISON OF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
    DIMENSION TITLE1(12),TITLE2(12),RPER(5),DR(5),RPERN(5)
    COUNT=0.0
120 READ INPUT TAPE 2,202,TITLE1,G,RIN,RPLAN,W
202 FORMAT (12A6,/4E12.0)
    DUAL=0.0
110 READ INPUT TAPE 2,203,TITLE2,VIN
203 FORMAT (12A6,/E12.0)
    DELV=W*29.8
    EO=(VIN*VIN)/2.0-G/RIN
    VINF2=2.0*EO
    RO=2.0*G/VINF2
    RPER(1)=RO
    COUNT=COUNT+1.0
    IF(COUNT-8.0)2,2,3
  2 RPER(2)=1.1*RPLAN
    GO TO 6
  3 RPER(2)=6690.0
  6 AO=G/(2.*EO)
    DO 40 I=1,2
    WRITE OUTPUT TAPE 3,301,TITLE1,TITLE2
301 FORMAT (12A6,/12A6)
    ECCO=(RPER(I)/AO)+1.0
    BO=AO*SQRTF((ECCO*ECCO)-1.0)
    VOO=SQRTF(G*(2.0/RPER(I)+1.0/AO))
    HO=RPER(I)*VOO
    VCO=SQRTF(G/RPER(I))
    DVO=VOO-VCO
    DVON=DVO/29.8
    BON=BO/RPLAN
    RPERN(I)=RPER(I)/RPLAN
    AON=AO/RPLAN
    WRITE OUTPUT TAPE 3,302,BON,AON,ECCO
302 FORMAT (10X,4HBON=E11.4,5X,4HAON=E11.4,5X,5HECCO=E11.4)
    DO 40 K=1,2
    R=RIN
    SFIO=HO/(R*VIN)
    FIO=ASIN(SFIO)
    IF(K-1)20,20,21
 20 VOV2=VIN*VIN+DELV*DELV
    VOV=SQRTF(VOV2)
    FI=FIO+ATANF(DELV/VIN)
    WRITE OUTPUT TAPE 3,311
311 FORMAT (10X,16HTRANSVERSE ERROR,/13X,2HRN,11X,
   16HDELRPN,10X,1HP,13X,1HQ)
    GO TO 22
 21 VOV=VIN+DELV
    FI=FIO
    WRITE OUTPUT TAPE 3,310
310 FORMAT (10X,18HLONGITUDINAL ERROR,/13X,2HRN,11X,
   16HDELRPN,10X,1HP,13X,1HQ)
 22 ATRU=(G*R)/(R*(VOV*VOV)-2.0*G)
    HTRU=R*VOV*SINF(FI)
```

```
      ETRU=G/(2.0*ATRU)
      BTRU=SQRTF((HTRU*HTRU)/(2.0*ETRU))
      ECTRU=SQRTF((BTRU*BTRU)/(ATRU*ATRU)+1.0)
      ROTRU=ATRU*(ECTRU-1.)
      DELRPN=(ROTRU-RPER(I))/RPLAN
      PIN=DELRPN/W
      RN=R/RPLAN
      QQ=1.0
      WRITE OUTPUT TAPE 3,303,RN,DELRPN,PIN,QQ
      DR(I)=(RIN-RPER(I))/5.0
      R=RPER(I)
      DO 40 J=1,4
      R=R+DR(I)
      RN=R/RPLAN
      VO=SQRTF(G*(2.0/R+1.0/AO))
      SFIO=HO/(R*VO)
      FIO=ASIN(SFIO)
      IF(K-1)30,30,31
   30 VOV2=VO*VO+DELV*DELV
      VOV=SQRTF(VOV2)
      FI=FIO+ATANF(DELV/VO)
      GO TO 32
   31 VOV=VO+DELV
      FI=FIO
   32 ATRU=(G*R)/(R*(VOV*VOV)-2.0*G)
      HTRU=R*VOV*SINF(FI)
      ETRU=G/(2.0*ATRU)
      BTRU=SQRTF((HTRU*HTRU)/(2.0*ETRU))
      ECTRU=SQRTF((BTRU*BTRU)/(ATRU*ATRU)+1.0)
      ROTRU=ATRU*(ECTRU-1.)
      DELRPN=(ROTRU-RPER(I))/RPLAN
      P=DELRPN/W
      Q=P/PIN
   40 WRITE OUTPUT TAPE 3,303,RN,DELRPN,P,Q
  303 FORMAT (9X,E11.4,5X,3(E11.4,4X))
      DUAL=DUAL+1.0
      IF(DUAL-4.0)110,120,120
      END(1,0,0,0,0,0,0,1,0,0,1,0,0,0,0,0)
```

```
GRH VARIATIONS ON PERI-APSIS DISTANCE

      DIMENSION TITLE1(12),TITLE2(12),RPER(5),DR(5),RPERN(5)
      COUNT=0.0
120   READ INPUT TAPE 2,202,TITLE1,G,RIN,RPLAN,W
202   FORMAT (12A6,/4E12.0)
      DUAL=0.0
110   READ INPUT TAPE 2,203,TITLE2,VIN
203   FORMAT (12A6,/E12.0)
      DELV=W*29.8
      E0=(VIN*VIN)/2.0-G/RIN
      VINF2=2.0*E0
      R0=2.0*G/VINF2
      RPER(1)=R0
      COUNT=COUNT+1.0
      IF(COUNT-8.0)2,2,3
    2 RPER(2)=1.1*RPLAN
      GO TO 6
    3 RPER(2)=6690.0
    6 A0=G/(2.*E0)
      DO 70 I=1,2
      WRITE OUTPUT TAPE 3,301,TITLE1,TITLE2
301   FORMAT (12A6,/12A6)
      ECC0=(RPER(I)/A0)+1.0
      B0=A0*SQRTF((ECC0*ECC0)-1.0)
      V00=SQRTF(G*(2.0/RPER(I)+1.0/A0))
      H0=RPER(I)*V00
      VC0=SQRTF(G/RPER(I))
      DV0=V00-VC0
      DV0N=DV0/29.8
      BON=B0/RPLAN
      RPERN(I)=RPER(I)/RPLAN
      WRITE OUTPUT TAPE 3,302,BON,I,RPERN(I),DV0N
302   FORMAT (10X,4HBON=E11.4,5X,6HRPERN(,I1,2H)=,E11.4,5X,
     15HDV0N=E11.4,/1H0,12X,2HRN,11X,6HDELRPN,12X,1HP,14X,1HQ)
      R=RIN
      SFI0=H0/(R*VIN)
      FI0=ASIN(SFI0)
      V0V2=VIN*VIN+DELV*DELV
      V0V=SQRTF(V0V2)
      FI=FI0+ATANF(DELV/VIN)
      ATRU=(G*R)/(R*(V0V*V0V)-2.0*G)
      HTRU=R*V0V*SINF(FI)
      ETRU=G/(2.0*ATRU)
      BTRU=SQRTF((HTRU*HTRU)/(2.0*ETRU))
      ECTRU=SQRTF((BTRU*BTRU)/(ATRU*ATRU)+1.0)
      ROTRU=ATRU*(ECTRU-1.)
      DELRPN=(ROTRU-RPER(I))/RPLAN
      PIN=DELRPN/W
      RN=R/RPLAN
      QQ=1.0
      WRITE OUTPUT TAPE 3,303,RN,DELRPN,PIN,QQ
      DR(I)=(RIN-RPER(I))/20.0
      R=RPER(I)
```

```
      DO 40 J=1,19
      R=R+DR(I)
      RN=R/RPLAN
      VO=SQRTF(G*(2.0/R+1.0/AO))
      SFIO=HU/(R*VO)
      FIO=ASIN(SFIO)
      VOV2=VO*VO+DELV*DELV
      VOV=SQRTF(VOV2)
      FI=FIO+ATANF(DELV/VO)
      ATRU=(G*R)/(R*(VOV*VOV)-2.0*G)
      HTRU=R*VOV*SINF(FI)
      ETRU=G/(2.0*ATRU)
      BTRU=SQRTF((HTRU*HTRU)/(2.0*ETRU))
      ECTRU=SQRTF((BTRU*BTRU)/(ATRU*ATRU)+1.0)
      ROTRU=ATRU*(ECTRU-1.)
      DELRPN=(ROTRU-RPER(I))/RPLAN
      P=DELRPN/W
      Q=P/PIN
   40 WRITE OUTPUT TAPE 3,303,RN,DELRPN,P,Q
  303 FORMAT (9X,E11.4,5X,3(E11.4,4X))
      WRITE OUTPUT TAPE 3,365
  365 FORMAT (1H1)
      DO 70 M=1,5
      GO TO (61,62,63,64,65),M
61    X=0.1
      GO TO 66
62    X=0.25
      GO TO 66
63    X=0.5
      GO TO 66
64    X=0.75
      GO TO 66
65    X=1.0
   66 FP=(RPERN(I)-1.0)/(10.0*W*X)
      FQ=FP/PIN
      FM=1.0/FQ
      ON=2.0*LOGF(FM)
      N=ON
      TEST=N
      COMP=ON-TEST
      IF(COMP-0.5)68,68,67
67    N=N+1
   68 NOPT=N
      WRITE OUTPUT TAPE 3,304,M,FQ,FM,NOPT
304   FORMAT (1HA,9X,2HM=I1,2X,3HFQ=E11.4,6X,3HFM=E11.4,6X,
     15HNOPT=I2,/11X,1HN,3X,11HRED. FACTOR,5X,11HMULT.FACTOR,
     24X,5HSUM/W,10X,8HSUM/29.8)
      N=N+1
      DO 70 L=1,5
      N=N-1
      IF(N)70,70,71
71    YY=N
      Y=1.0/YY
      SUM=(SQRTF(YY))*(FM**Y)
```

```
      RED=FC**Y
      T=1.0/RED
      SUM2=SUM/29.8
      WRITE OUTPUT TAPE 3,305,N,RED,T,SUM,SUM2
305   FORMAT (10X,I2,3X,4(E11.4,4X))
70    CONTINUE
      DUAL=DUAL+1.0
      IF(DUAL-4.0)110,120,120
      END(1,0,0,0,0,0,1,0,0,1,0,0,0,0,0)
```

```
 GRH TIME TO PERI-APSIS IN MINUTES
      DIMENSION TITLE1(12)
  110 READ INPUT TAPE 2,203,G,RIN,RPLAN
 203  FORMAT (3E10.0)
      DUAL=0.0
  120 DO 11 I=1,2
      READ INPUT TAPE 2,202,AON,ECCO,RPERN,NN,JJ,TITLE1
 202  FORMAT (3E10.0,2I5,/12A6)
      IF(JJ)2,2,3
    2 GO TO 11
    3 N1=0
      A=AON*RPLAN
      TTT=(A**1.5)/SQRTF(G)
      COSHFI=(1.0/ECCO)*(1.0+RIN/AON)
      COSH2=COSHFI*COSHFI
      SINHFI=SQRTF(COSH2-1.0)
      FI=LOGF(COSHFI+SQRTF(COSH2-1.0))
      TT=TTT*(ECCO*SINHFI-FI)*(1.0/60.0)
      TT1=TT
      N=NN
      DO 10 J=1,JJ
      WRITE OUTPUT TAPE 3,304
  304 FORMAT (1H2,9X,31HTIME FROM PERI-APSIS IN MINUTES)
      DT=0.0
      TT=TT1
      READ INPUT TAPE 2,201,Q
 201  FORMAT (E10.0)
      N=N+1
      WRITE OUTPUT TAPE 3,305,TITLE1,N,N1,RIN,TT1,DT
  305 FORMAT (12A6,/10X,I2,2X,16HCORRECTION STEPS,
     1/11X,1HN,5X,5HRANGE,11X,4HTIME,8X,10HDELTA-TIME,
     2/10X,I2,2X,E11.4,2(4X,E11.4))
      DO 10 K=1,N
      RN=(RIN-RPERN)*(Q**K)+RPERN
      COSHFI=(1.0/ECCO)*(1.0+RN/AON)
      COSH2=COSHFI*COSHFI
      SINHFI=SQRTF(COSH2-1.0)
      FI=LOGF(COSHFI+SQRTF(COSH2-1.0))
      T=TTT*(ECCO*SINHFI-FI)*(1.0/60.0)
      DT=TT-T
      TT=T
      WRITE OUTPUT TAPE 3,303,K,RN,T,DT
 303  FORMAT (10X,I2,2X,E11.4,2(4X,E11.4))
   10 CONTINUE
   11 CONTINUE
      DUAL=DUAL+1.0
      IF(DUAL-4.0)120,110,110
      END(1,0,0,0,0,0,1,0,0,1,0,0,0,0,0)
```

ITERATIØN NUMBER 14

```
2   6   6 .51368571E+02 .65164190E+01
3   6   6 .85345189E+02-.10487910E+01
4   6   6 .83703602E+02 .52751590E+01
5   6   6 .80649055E+02 .72502880E+01
6   6   6 .79693043E+02 .88220270E+01
```

ITERATIØN NUMBER 15

```
2   6   6 .51339767E+02-.28804000E-01
3   6   6 .77532625E+02-.78125640E+01
4   6   6 .84251769E+02 .54816700E+00
5   6   6 .85209332E+02 .45602770E+01
6   6   6 .85549536E+02 .58564930E+01
```

ITERATIØN NUMBER 16

```
2   6   6 .47631880E+02-.37078870E+01
3   6   6 .74328679E+02-.32039460E+01
4   6   6 .84750529E+02 .49876000E+00
5   6   6 .88309144E+02 .30998120E+01
6   6   6 .89347939E+02 .37984030E+01
```

ITERATIØN NUMBER 17

```
2   6   6 .45810482E+02-.18213980E+01
3   6   6 .72268586E+02-.20600930E+01
4   6   6 .84915766E+02 .16523700E+00
5   6   6 .90204296E+02 .18951520E+01
6   6   6 .91824796E+02 .24768570E+01
```

ITERATIØN NUMBER 18

```
3   6   6-.1341 200E+03-.20638058E+03 .99188337E+00
```

ITERATIØN NUMBER 19

```
2   6   6 .85797480E+01-.35130178E+02
3   6   6 .46369107E+02 .180481 0E+03
4   6   6 .75833670E+02 .25041713E+02
5   6   6 .88148656E+02 .24035820E+01
6   6   6 .89534468E+02-.10191980E+01
```

ITERATIØN NUMBER 20

```
2   6   6 .34557193E+02 .25977445E+02
3   6   6 .51224439E+02 .48553320E+01
4   6   6 .74969384E+02-.86428600E+00
5   6   6 .86551262E+02-.15973940E+01
6   6   6 .89934059E+02 .39959100E+00
```

TIME FROM PERI-APSIS IN MINUTES

CLASS BI--1/2,1--H VENUS-OPT

1 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.1635E 03	0.5733E 04	0.
1	0.9883E 02	0.3353E 04	0.2381E 04

COMPARISON OF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS BI--1/2.1--H VENUS
BCN= 0.4159E 01 AON= 0.7313E 01 ECCO= 0.1150E 01
TRANSVERSE ERROR

RN	DELRPN	P	Q
0.1635E 03	0.1518E 01	0.1076E C4	0.1000E 01
0.3357E 02	0.2704E-00	0.1918E 03	0.1782E-00
0.6604E 02	0.5556E 00	0.3940E 03	0.3661E-00
0.9852E 02	0.8596E 00	0.6096E C3	0.5664E 00
0.1310E 03	0.1181E 01	0.8375E C3	0.7780E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.1635E 03	0.2855E-01	0.2024E C2	0.1000E 01
0.3357E 02	0.2418E-01	0.1715E C2	0.8472E 00
0.6604E 02	0.2667E-01	0.1892E C2	0.9345E 00
0.9852E 02	0.2767E-01	0.1963E C2	0.9694E 00
0.1310E 03	0.2821E-01	0.2001E C2	0.9882E 00

VARIATIONS CN PERI-APSIS DISTANCE--VENUS
CLASS BI--1/2.1--H
BCN= 0.4159E 01 RPERN(2)= 0.1100E 01 DVON= 0.1083E-00

RN	DELRPN	P	Q
0.1635E 03	0.1518E 01	0.1076E C4	0.1000E 01
0.9218E 01	0.6935E-01	0.4918E 02	0.4569E-01
0.1734E 02	0.1353E-00	0.9593E C2	0.8912E-01
0.2545E 02	0.2023E-00	0.1434E C3	0.1333E-00
0.3357E 02	0.2704E-00	0.1918E C3	0.1782E-00
0.4169E 02	0.3399E-00	0.2411E C3	0.2239E-00
0.4981E 02	0.4106E-00	0.2912E C3	0.2705E-00
0.5793E 02	0.4825E-00	0.3422E C3	0.3179E-00
0.6604E 02	0.5556E 00	0.3940E C3	0.3661E-00
0.7416E 02	0.6299E 00	0.4467E C3	0.4150E-00
0.8228E 02	0.7053E 00	0.5002E C3	0.4647E-00
0.9040E 02	0.7819E 00	0.5545E C3	0.5152E 00
0.9852E 02	0.8596E 00	0.6096E C3	0.5664E 00
0.1066E 03	0.9383E 00	0.6655E 03	0.6183E 00
0.1148E 03	0.1018E 01	0.7221E C3	0.6708E 00
0.1229E 03	0.1099E 01	0.7794E C3	0.7241E 00
0.1310E 03	0.1181E 01	0.8375E C3	0.7780E 00
0.1391E 03	0.1264E 01	0.8962E C3	0.8326E 00
0.1472E 03	0.1347E 01	0.9556E C3	0.8878E 00
0.1553E 03	0.1432E 01	0.1016E C4	0.9436E 00

M=1	FQ= 0.6589E-01	FM= 0.1518E 02	NCPT= 5	
N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
5	0.5804E 00	0.1723E 01	0.3852E 01	0.1293E-00
4	0.5066E 00	0.1974E 01	0.3948E 01	0.1325E-00
3	0.4039E-00	0.2476E 01	0.4288E 01	0.1439E-00
2	0.2567E-00	0.3896E 01	0.5509E 01	0.1849E-00
1	0.6589E-01	0.1518E 02	0.1518E 02	0.5093E 00

M=2	FQ= 0.2636E-01	FM= 0.3794E 02	NOPT= 7	
N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
7	0.5949E 00	0.1681E 01	0.4448E 01	0.1493E-00
6	0.5455E 00	0.1833E 01	0.4490E 01	0.1507E-00
5	0.4833E-00	0.2069E 01	0.4627E 01	0.1553E-00
4	0.4029E-00	0.2482E 01	0.4964E 01	0.1666E-00
3	0.2976E-00	0.3360E 01	0.5820E 01	0.1953E-00

M=3	FQ= 0.1318E-01	FM= 0.7589E 02	NOPT= 9	
N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
9	0.6181E 00	0.1618E 01	0.4853E 01	0.1629E-00
8	0.5821E 00	0.1718E 01	0.4859E 01	0.1631E-00
7	0.5388E 00	0.1856E 01	0.4911E 01	0.1648E-00
6	0.4860E-00	0.2058E 01	0.5040E 01	0.1691E-00
5	0.4207E-00	0.2377E 01	0.5315E 01	0.1784E-00

M=4	FQ= 0.8785E-02	FM= 0.1138E 03	NOPT= 9	
N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
9	0.5909E 00	0.1692E 01	0.5077E 01	0.1704E-00
8	0.5533E 00	0.1807E 01	0.5112E 01	0.1715E-00
7	0.5085E 00	0.1967E 01	0.5204E 01	0.1746E-00
6	0.4542E-00	0.2201E 01	0.5392E 01	0.1810E-00
5	0.3879E-00	0.2578E 01	0.5764E 01	0.1934E-00

M=5	FQ= 0.6589E-02	FM= 0.1518E 03	NOPT=10	
N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
10	0.6052E 00	0.1652E 01	0.5225E 01	0.1753E-00
9	0.5723E 00	0.1747E 01	0.5242E 01	0.1759E-00
8	0.5338E 00	0.1873E 01	0.5299E 01	0.1778E-00
7	0.4880E-00	0.2049E 01	0.5422E 01	0.1819E-00
6	0.4330E-00	0.2310E 01	0.5657E 01	0.1898E-00

TIME FROM PERI-APSIS IN MINUTES

CLASS BI--1/2,1--H VENUS-CLOSE
6 . CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.1635E 03	0.5510E 04	0.
1	0.7142E 02	0.2183E 04	0.3326E 04
2	0.3155E 02	0.8355E 03	0.1348E 04
3	0.1428E 02	0.3156E 03	0.5200E 03
4	0.6809E 01	0.1245E 03	0.1911E 03
5	0.3572E 01	0.5486E 02	0.6959E 02
6	0.2170E 01	0.2787E 02	0.2700E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS BI--1/2,1--H VENUS-CLOSE
8 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.1635E 03	0.5510E 04	0.
1	0.8779E 02	0.2762E 04	0.2748E 04
2	0.4737E 02	0.1356E 04	0.1406E 04
3	0.2580E 02	0.6548E 03	0.7011E 03
4	0.1429E 02	0.3156E 03	0.3392E 03
5	0.8138E 01	0.1558E 03	0.1598E 03
6	0.4857E 01	0.8124E 02	0.7458E 02
7	0.3106E 01	0.4572E 02	0.3552E 02
8	0.2171E 01	0.2787E 02	0.1785E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS BI--1/2,1--H VENUS-CLOSE
10 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.1635E 03	0.5510E 04	0.
1	0.9938E 02	0.3176E 04	0.2334E 04
2	0.6058E 02	0.1806E 04	0.1369E 04
3	0.3710E 02	0.1015E 04	0.7916E 03
4	0.2289E 02	0.5656E 03	0.4493E 03
5	0.1429E 02	0.3156E 03	0.2500E 03
6	0.9080E 01	0.1788E 03	0.1368E 03
7	0.5929E 01	0.1045E 03	0.7428E 02
8	0.4023E 01	0.6391E 02	0.4062E 02
9	0.2869E 01	0.4115E 02	0.2276E 02
10	0.2170E 01	0.2787E 02	0.1328E 02

COMPARISON OF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS EX---0.0---A VENUS
BON= 0.3026E 01 AON= 0.1070E 01 ECCO= 0.3000E 01

TRANSVERSE ERROR

RN	DELRPN	P	Q
0.1635E 03	0.9359E 00	0.6637E 03	0.1000E 01
0.3440E 02	0.1943E-00	0.1378E 03	0.2076E-00
0.6667E 02	0.3786E-00	0.2685E 03	0.4045E-00
0.9893E 02	0.5636E 00	0.3997E 03	0.6023E 00
0.1312E 03	0.7494E 00	0.5315E 03	0.8008E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.1635E 03	0.8324E-02	0.5904E 01	0.1000E 01
0.3440E 02	0.7724E-02	0.5478E 01	0.9279E 00
0.6667E 02	0.8088E-02	0.5736E 01	0.9716E 00
0.9893E 02	0.8217E-02	0.5828E 01	0.9872E 00
0.1312E 03	0.8284E-02	0.5875E 01	0.9951E 00

VARIATIONS ON PERI-APSIS DISTANCE--VENUS
CLASS EX---0.0---A
BON= 0.3026E 01 RPERN(1)= 0.2139E 01 DVON= 0.1664E-00

RN	DELRPN	P	Q
0.1635E 03	0.9359E 00	0.6637E 03	0.1000E 01
0.1021E 02	0.5554E-01	0.3939E 02	0.5934E-01
0.1827E 02	0.1021E-00	0.7240E 02	0.1091E-00
0.2634E 02	0.1482E-00	0.1051E 03	0.1584E-00
0.3440E 02	0.1943E-00	0.1378E 03	0.2076E-00
0.4247E 02	0.2403E-00	0.1704E 03	0.2568E-00
0.5054E 02	0.2863E-00	0.2031E 03	0.3060E-00
0.5860E 02	0.3324E-00	0.2358E 03	0.3552E-00
0.6667E 02	0.3786E-00	0.2685E 03	0.4045E-00
0.7473E 02	0.4248E-00	0.3013E 03	0.4539E-00
0.8280E 02	0.4710E-00	0.3340E 03	0.5033E 00
0.9087E 02	0.5173E 00	0.3669E 03	0.5527E 00
0.9893E 02	0.5636E 00	0.3997E 03	0.6023E 00
0.1070E 03	0.6100E 00	0.4326E 03	0.6518E 00
0.1151E 03	0.6564E 00	0.4656E 03	0.7014E 00
0.1231E 03	0.7029E 00	0.4985E 03	0.7511E 00
0.1312E 03	0.7494E 00	0.5315E 03	0.8008E 00
0.1393E 03	0.7960E 00	0.5645E 03	0.8505E 00
0.1473E 03	0.8426E 00	0.5976E 03	0.9003E 00
0.1554E 03	0.8892E 00	0.6306E 03	0.9501E 00

```
M=2  FQ= 0.4870E-00       FM= 0.2053E 01       NCPT= 1
 N   RED. FACTOR       MULT.FACTOR    SUM/W              SUM/29.8
 1     0.4870E-00      0.2053E 01     0.2053E 01         0.6891E-01

M=3  FQ= 0.2435E-00       FM= 0.4107E 01       NOPT= 3
 N   RED. FACTOR       MULT.FACTOR    SUM/W              SUM/29.8
 3     0.6244E 00      0.1601E 01     0.2774E 01         0.9308E-01
 2     0.4935E-00      0.2027E 01     0.2866E 01         0.9617E-01
 1     0.2435E-00      0.4107E 01     0.4107E 01         0.1378E-00

M=4  FQ= 0.1623E-00       FM= 0.6160E 01       NOPT= 4
 N   RED. FACTOR       MULT.FACTOR    SUM/W              SUM/29.8
 4     0.6347E 00      0.1575E 01     0.3151E 01         0.1057E-00
 3     0.5455E 00      0.1833E 01     0.3175E 01         0.1065E-00
 2     0.4029E-00      0.2482E 01     0.3510E 01         0.1178E-00
 1     0.1623E-00      0.6160E 01     0.6160E 01         0.2067E-00

M=5  FQ= 0.1217E-00       FM= 0.8214E 01       NOPT= 4
 N   RED. FACTOR       MULT.FACTOR    SUM/W              SUM/29.8
 4     0.5907E 00      0.1693E 01     0.3386E 01         0.1136E-00
 3     0.4956E-00      0.2018E 01     0.3495E 01         0.1173E-00
 2     0.3489E-00      0.2866E 01     0.4053E 01         0.1360E-00
 1     0.1217E-00      0.8214E 01     0.8214E 01         0.2756E-00
TIME FROM PERI-APSIS IN MINUTES

CLASS    EX---0,0---A      VENUS-OPT
 1  CORRECTION STEPS
 N      RANGE             TIME          DELTA-TIME
 0   0.1635E 03      0.2343E 04       0.
 1   0.2178E 02      0.2905E 03       0.2053E 04

TIME FROM PERI-APSIS IN MINUTES

CLASS    EX---0,0---A      VENUS-OPT
 3  CORRECTION STEPS
 N      RANGE             TIME          DELTA-TIME
 0   0.1635E 03      0.2343E 04       0.
 1   0.8211E 02      0.1158E 04       0.1185E 04
 2   0.4177E 02      0.5757E 03       0.5827E 03
 3   0.2178E 02      0.2906E 03       0.2852E 03
TIME FROM PERI-APSIS IN MINUTES

CLASS    EX---0,0---A      VENUS-OPT
 4  CORRECTION STEPS
 N      RANGE             TIME          DELTA-TIME
 0   0.1635E 03      0.2343E 04       0.
 1   0.9745E 02      0.1381E 04       0.9620E 03
 2   0.5844E 02      0.8158E 03       0.5654E 03
 3   0.3540E 02      0.4844E 03       0.3315E 03
 4   0.2178E 02      0.2906E 03       0.1937E 03
```

COMPARISON OF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS EX---0.0---A VENUS
BCN= 0.1888E 01 AON= 0.1070E 01 ECCO= 0.2028E 01
TRANSVERSE ERROR

RN	DELRPN	P	Q
0.1635E 03	0.8901E 00	0.6313E C3	0.1000E 01
0.3357E 02	0.1768E-00	0.1254E 03	0.1986E-00
0.6604E 02	0.3516E-00	0.2494E C3	0.3950E-00
0.9852E 02	0.5291E 00	0.3752E 03	0.5943E 00
0.1310E 03	0.7087E 00	0.5026E C3	0.7962E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.1635E 03	0.6382E-02	0.4526E C1	0.1000E 01
0.3357E 02	0.6064E-02	0.4301E C1	0.9502E 00
0.6604E 02	0.6259E-02	0.4439E 01	0.9807E 00
0.9852E 02	0.6327E-02	0.4487E C1	0.9913E 00
0.1310E C3	0.6361E-02	0.4511E 01	0.9967E 00

VARIATIONS CN PERI-APSIS DISTANCE--VENUS
CLASS EX---0.0---A
BCN= 0.1888E C1 RPERN(2)= 0.1100E 01 DVON= 0.1718E-00

RN	DELRPN	P	Q
0.1635E 03	0.8901E 00	C.6313E C3	0.1000E 01
0.9218E 01	0.4737E-01	0.3359E 02	0.5321E-01
0.1734E 02	0.9044E-01	0.6414E 02	0.1016E-00
0.2545E 02	0.1335E-00	0.9470E C2	0.1500E-00
0.3357E 02	0.1768E-00	0.1254E C3	0.1986E-00
0.4169E 02	0.2202E-00	0.1562E C3	0.2474E-00
0.4981E 02	0.2638E-00	0.1871E 03	0.2964E-00
0.5793E 02	0.3076E-00	0.2182E 03	0.3456E-00
0.6604E 02	0.3516E-00	0.2494E 03	0.3950E-00
0.7416E 02	0.3957E-00	0.2807E 03	0.4446E-00
0.8228E 02	0.4400E-00	0.3121E C3	0.4943E-00
0.9040E 02	0.4845E-00	0.3436E C3	0.5443E 00
0.9852E 02	0.5291E 00	0.3752E 03	0.5943E 00
0.1066E 03	0.5738E 00	0.4069E C3	0.6446E 00
0.1148E 03	0.6186E 00	0.4387E C3	0.6950E 00
0.1229E 03	0.6636E 00	0.4706E C3	0.7455E 00
0.1310E 03	0.7087E 00	0.5026E 03	0.7962E 00
0.1391E 03	0.7539E 00	0.5347E C3	0.8469E 00
0.1472E 03	0.7992E 00	0.5668E C3	0.8978E 00
0.1553E 03	0.8446E 00	0.5990E C3	0.9489E 00

M=1	FQ= 0.1123E-00	FM= 0.8901E 01	NOPT= 4	
N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
4	0.5789E 00	0.1727E 01	0.3455E 01	0.1159E-00
3	0.4825E-00	0.2072E 01	0.3590E 01	0.1205E-00
2	0.3352E-00	0.2984E 01	0.4219E 01	0.1416E-00
1	0.1123E-00	0.8901E 01	0.8901E 01	0.2987E-00

M=2	FQ= 0.4494E-01	FM= 0.2225E 02	NOPT= 6	
N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
6	0.5963E 00	0.1677E 01	0.4108E 01	0.1379E-00
5	0.5377E 00	0.1860E 01	0.4159E 01	0.1396E-00
4	0.4604E-00	0.2172E 01	0.4344E 01	0.1458E-00
3	0.3555E-00	0.2813E 01	0.4872E 01	0.1635E-00
2	0.2120E-00	0.4717E 01	0.6671E 01	0.2239E-00

M=3	FQ= 0.2247E-01	FM= 0.4451E 02	NOPT= 8	
N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
8	0.6222E 00	0.1607E 01	0.4546E 01	0.1525E 00
7	0.5814E 00	0.1720E 01	0.4550E 01	0.1527E-00
6	0.5312E 00	0.1883E 01	0.4611E 01	0.1547E-00
5	0.4681E-00	0.2136E 01	0.4777E 01	0.1603E-00
4	0.3872E-00	0.2583E 01	0.5166E 01	0.1733E-00

M=4	FQ= 0.1498E-01	FM= 0.6676E 02	NOPT= 8	
N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
8	0.5915E 00	0.1691E 01	0.4782E 01	0.1605E-00
7	0.5487E 00	0.1822E 01	0.4822E 01	0.1618E-00
6	0.4965E-00	0.2014E 01	0.4934E 01	0.1656E-00
5	0.4316E-00	0.2317E 01	0.5181E 01	0.1738E-00
4	0.3498E-00	0.2858E 01	0.5717E 01	0.1918E-00

M=5	FQ= 0.1123E-01	FM= 0.8901E 02	NOPT= 9	
N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
9	0.6073E 00	0.1647E 01	0.4940E 01	0.1658E-00
8	0.5706E 00	0.1753E 01	0.4957E 01	0.1663E-00
7	0.5266E 00	0.1899E 01	0.5024E 01	0.1686E-00
6	0.4732E-00	0.2113E 01	0.5176E 01	0.1737E-00
5	0.4075E-00	0.2454E 01	0.5488E 01	0.1841E-00

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---A VENUS-CLOSE
5 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.1635E 03	0.2337E 04	0.
1	0.6728E 02	0.9380E 03	0.1399E 04
2	0.2807E 02	0.3750E 03	0.5630E 03
3	0.1209E 02	0.1515E 03	0.2235E 03
4	0.5578E 01	0.6423E 02	0.8725E 02
5	0.2925E 01	0.3009E 02	0.3414E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---A VENUS-CLOSE
7 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.1635E 03	0.2337E 04	0.
1	0.8662E 02	0.1218E 04	0.1119E 04
2	0.4613E 02	0.6331E 03	0.5851E 03
3	0.2482E 02	0.3289E 03	0.3042E 03
4	0.1359E 02	0.1721E 03	0.1569E 03
5	0.7676E 01	0.9187E 02	0.8018E 02
6	0.4563E 01	0.5107E 02	0.4080E 02
7	0.2924E 01	0.3007E 02	0.2100E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---A VENUS-CLOSE
9 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.1635E 03	0.2337E 04	0.
1	0.9973E 02	0.1409E 04	0.9289E 03
2	0.6100E 02	0.8472E 03	0.5613E 03
3	0.3747E 02	0.5090E 03	0.3382E 03
4	0.2319E 02	0.3060E 03	0.2030E 03
5	0.1452E 02	0.1848E 03	0.1212E 03
6	0.9247E 01	0.1129E 03	0.7194E 02
7	0.6048E 01	0.7037E 02	0.4253E 02
8	0.4105E 01	0.4518E 02	0.2519E 02
9	0.2925E 01	0.3008E 02	0.1509E 02

VARIATIONS ON PERI-APSIS DISTANCE--VENUS
CLASS EX---C.0---C
BON= 0.8575E 00 RPERN(1)= 0.6063E 00 DVON= 0.3126E-00

COMPARISON OF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS EX---C.0---C VENUS
BON= 0.1370E 01 AON= 0.3032E-00 ECCO= 0.4628E 01

TRANSVERSE ERROR

RN	DELRPN	P	Q
0.1635E 03	0.5123E 00	0.3633E 03	0.1000E 01
0.3357E 02	0.1046E-00	0.7420E 02	0.2042E-00
0.6604E 02	0.2062E-00	0.1463E 03	0.4026E-00
0.9852E 02	0.3081E-00	0.2185E 03	0.6014E 00
0.1310E 03	0.4101E-00	0.2908E 03	0.8005E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.1635E 03	0.1497E-02	0.1062E 01	0.1000E 01
0.3357E 02	0.1447E-02	0.1026E 01	0.9669E 00
0.6604E 02	0.1478E-02	0.1048E 01	0.9873E 00
0.9852E 02	0.1488E-02	0.1056E 01	0.9943E 00
0.1310E 03	0.1494E-02	0.1059E 01	0.9979E 00

VARIATIONS ON PERI-APSIS DISTANCE--VENUS
CLASS EX---C.0---C
BON= 0.1370E 01 RPERN(2)= 0.1100E 01 DVON= 0.3186E-00

RN	DELRPN	P	Q
0.1635E 03	0.5123E 00	0.3633E 03	0.1000E 01
0.9218E 01	0.2841E-01	0.2015E 02	0.5547E-01
0.1734E 02	0.5386E-01	0.3820E 02	0.1051E-00
0.2545E 02	0.7924E-01	0.5620E 02	0.1547E-00
0.3357E 02	0.1046E-00	0.7420E 02	0.2042E-00
0.4169E 02	0.1300E-00	0.9220E 02	0.2538E-00
0.4981E 02	0.1554E-00	0.1102E 03	0.3034E-00
0.5793E 02	0.1808E-00	0.1282E 03	0.3530E-00
0.6604E 02	0.2062E-00	0.1463E 03	0.4026E-00
0.7416E 02	0.2317E-00	0.1643E 03	0.4523E-00
0.8228E 02	0.2571E-00	0.1824E 03	0.5019E 00
0.9040E 02	0.2826E-00	0.2004E 03	0.5516E 00
0.9852E 02	0.3081E-00	0.2185E 03	0.6014E 00
0.1066E 03	0.3336E 00	0.2366E 03	0.6511E 00
0.1148E 03	0.3591E-00	0.2546E 03	0.7009E 00
0.1229E 03	0.3846E-00	0.2727E 03	0.7507E 00
0.1310E 03	0.4101E-00	0.2908E 03	0.8005E 00
0.1391E 03	0.4356E-00	0.3089E 03	0.8504E 00
0.1472E 03	0.4612E-00	0.3271E 03	0.9002E 00
0.1553E 03	0.4867E-00	0.3452E 03	0.9501E 00

M=1 FQ= 0.1952E-00 FM= 0.5123E 01 NOPT= 3

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
3	0.5801E 00	0.1724E 01	0.2986E 01	0.1002E-00
2	0.4418E-00	0.2263E 01	0.3201E 01	0.1074E-00
1	0.1952E-00	0.5123E 01	0.5123E 01	0.1719E-00

M=2 FQ= 0.7809E-01 FM= 0.1281E 02 NOPT= 5

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
5	0.6005E 00	0.1665E 01	0.3724E 01	0.1250E-00
4	0.5286E 00	0.1892E 01	0.3783E 01	0.1270E-00
3	0.4274E-00	0.2340E 01	0.4052E 01	0.1360E-00
2	0.2794E-00	0.3579E 01	0.5061E 01	0.1698E-00
1	0.7809E-01	0.1281E 02	0.1281E 02	0.4298E-00

M=3 FQ= 0.3904E-01 FM= 0.2561E 02 NOPT= 6

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
6	0.5824E 00	0.1717E 01	0.4206E 01	0.1411E-00
5	0.5228E 00	0.1913E 01	0.4277E 01	0.1435E-00
4	0.4445E-00	0.2250E 01	0.4499E 01	0.1510E-00
3	0.3392E-00	0.2948E 01	0.5106E 01	0.1713E-00
2	0.1976E-00	0.5061E 01	0.7157E 01	0.2402E-00

M=4 FQ= 0.2603E-01 FM= 0.3842E 02 NOPT= 7

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
7	0.5938E 00	0.1684E 01	0.4456E 01	0.1495E-00
6	0.5444E 00	0.1837E 01	0.4500E 01	0.1510E-00
5	0.4820E-00	0.2074E 01	0.4639E 01	0.1557E-00
4	0.4017E-00	0.2490E 01	0.4979E 01	0.1671E-00
3	0.2964E-00	0.3374E 01	0.5844E 01	0.1961E-00

M=5 FQ= 0.1952E-01 FM= 0.5123E 02 NOPT= 8

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
8	0.6114E 00	0.1636E 01	0.4626E 01	0.1552E-00
7	0.5699E 00	0.1755E 01	0.4643E 01	0.1558E-00
6	0.5189E 00	0.1927E 01	0.4721E 01	0.1584E-00
5	0.4551E-00	0.2197E 01	0.4913E 01	0.1649E-00
4	0.3738E-00	0.2675E 01	0.5351E 01	0.1796E-00

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---C VENUS-CLOSE
4 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.1635E 03	0.1267E 04	0.
1	0.6181E 02	0.4747E 03	0.7927E 03
2	0.2379E 02	0.1796E 03	0.2951E 03
3	0.9582E 01	0.7023E 02	0.1094E 03
4	0.4271E 01	0.2964E 02	0.4059E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---C VENUS-CLOSE
6 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.1635E 03	0.1267E 04	0.
1	0.8537E 02	0.6582E 03	0.6092E 03
2	0.4483E 02	0.3427E 03	0.3155E 03
3	0.2379E 02	0.1796E 03	0.1631E 03
4	0.1287E 02	0.9547E 02	0.8416E 02
5	0.7209E 01	0.5209E 02	0.4338E 02
6	0.4270E 01	0.2964E 02	0.2245E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---C VENUS-CLOSE
8 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.1635E 03	0.1267E 04	0.
1	0.1004E 03	0.7752E 03	0.4922E 03
2	0.6181E 02	0.4747E 03	0.3005E 03
3	0.3822E 02	0.2914E 03	0.1833E 03
4	0.2379E 02	0.1796E 03	0.1117E 03
5	0.1497E 02	0.1116E 03	0.6803E 02
6	0.9583E 01	0.7023E 02	0.4138E 02
7	0.6286E 01	0.4505E 02	0.2519E 02
8	0.4271E 01	0.2964E 02	0.1540E 02

COMPARISON CF LCNGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS EX---0.0---D VENUS
BCN= 0.1091E 02 AON= 0.3857E 01 ECCO= 0.3000E 01

TRANSVERSE ERROR

RN	DELRPN	P	Q
0.1635E 03	0.1763E 01	0.1251E 04	0.1000E 01
0.3886E 02	0.4033E-00	0.2861E 03	0.2288E-00
0.7001E 02	0.7450E 00	0.5284E 03	0.4225E-00
0.1012E 03	0.1084E 01	0.7691E 03	0.6150E 00
0.1323E 03	0.1424E 01	0.1010E 04	0.8074E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.1635E 03	0.5380E-01	0.3816E 02	0.1000E 01
0.3886E 02	0.4227E-01	0.2998E 02	0.7856E 00
0.7001E 02	0.4878E-01	0.3460E 02	0.9067E 00
0.1012E 03	0.5144E-01	0.3648E 02	0.9561E 00
0.1323E 03	0.5289E-01	0.3751E 02	0.9831E 00

VARIATIONS CN PERI-APSIS DISTANCE--VENUS
CLASS EX---0.0---D
BON= 0.1091E 02 RPERN(1)= 0.7714E 01 DVON= 0.8765E-01

RN	DELRPN	P	Q
0.1635E 03	0.1763E 01	0.1251E 04	0.1000E 01
0.1550E 02	0.1358E-00	0.9629E 02	0.7700E-01
0.2329E 02	0.2282E-00	0.1618E 03	0.1294E-00
0.3108E 02	0.3166E-00	0.2245E 03	0.1795E-00
0.3886E 02	0.4033E-00	0.2861E 03	0.2288E-00
0.4665E 02	0.4893E-00	0.3470E 03	0.2775E-00
0.5444E 02	0.5748E 00	0.4077E 03	0.3260E-00
0.6223E 02	0.6600E 00	0.4681E 03	0.3743E-00
0.7001E 02	0.7450E 00	0.5284E 03	0.4225E-00
0.7780E 02	0.8299E 00	0.5886E 03	0.4707E-00
0.8559E 02	0.9148E 00	0.6488E 03	0.5188E 00
0.9337E 02	0.9996E 00	0.7089E 03	0.5669E 00
0.1012E 03	0.1084E 01	0.7691E 03	0.6150E 00
0.1089E 03	0.1169E 01	0.8292E 03	0.6631E 00
0.1167E 03	0.1254E 01	0.8893E 03	0.7112E 00
0.1245E 03	0.1339E 01	0.9495E 03	0.7593E 00
0.1323E 03	0.1424E 01	0.1010E 04	0.8074E 00
0.1401E 03	0.1508E 01	0.1070E 04	0.8555E 00
0.1479E 03	0.1593E 01	0.1130E 04	0.9037E 00
0.1557E 03	0.1678E 01	0.1190E 04	0.9518E 00

```
M=3  FQ= 0.7616E 00       FM= 0.1313E 01        NOPT= 1
 N   RED. FACTOR      MULT.FACTOR    SUM/W             SUM/29.8
 1    0.7616E 00      0.1313E 01     0.1313E 01        0.4406E-01

M=4  FQ= 0.5077E 00       FM= 0.1970E 01        NOPT= 1
 N   RED. FACTOR      MULT.FACTOR    SUM/W             SUM/29.8
 1    0.5077E 00      0.1970E 01     0.1970E 01        0.6609E-01

M=5  FQ= 0.3808E-00       FM= 0.2626E 01        NOPT= 2
 N   RED. FACTOR      MULT.FACTOR    SUM/W             SUM/29.8
 2    0.6171E 00      0.1621E 01     0.2292E 01        0.7690E-01
 1    0.3808E-00      0.2626E 01     0.2626E 01        0.8812E-01
```

```
TIME FROM PERI-APSIS IN MINUTES

CLASS    EX---0,0---D       VENUS-OPT
 1  CORRECTION STEPS
 N      RANGE              TIME           DELTA-TIME
 0    0.1635E 03       0.4293E 04       0.
 1    0.6704E 02       0.1681E 04       0.2612E 04
```

```
TIME FROM PERI-APSIS IN MINUTES

CLASS    EX---0,0---D       VENUS-OPT
 2  CORRECTION STEPS
 N      RANGE              TIME           DELTA-TIME
 0    0.1635E 03       0.4293E 04       0.
 1    0.1038E 03       0.2671E 04       0.1622E 04
 2    0.6704E 02       0.1681E 04       0.9900E 03
```

COMPARISON CF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS EX---C.0---D VENUS
BON= 0.3114E 01 AON= 0.3857E 01 ECCO= 0.1285E 01

TRANSVERSE ERROR

RN	DELRPN	P	Q
0.1635E 03	0.1336E 01	0.9477E C3	0.1000E 01
0.3357E 02	0.2474E-00	0.1755E 03	0.1852E-00
0.6604E 02	0.5027E 00	0.3565E C3	0.3762E-00
0.9852E 02	0.7703E 00	0.5463E C3	0.5765E 00
0.1310E 03	0.1C49E 01	0.7436E 03	0.7847E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.1635E 03	0.1887E-01	0.1338E C2	0.1000E 01
0.3357E 02	0.1695E-01	0.1202E C2	0.8980E 00
0.6604E 02	0.1809E-01	0.1283E 02	0.9584E 00
0.9852E 02	0.1851E-01	0.1313E 02	0.9810E 00
0.1310E 03	0.1873E-01	0.1329E 02	0.9927E 00

VARIATIONS CN PERI-APSIS DISTANCE--VENUS
CLASS EX---0.0---D
BCN= 0.3114E C1 RPERN(2)= 0.110CE 01 DVON= 0.1188E-00

RN	DELRPN	P	Q
0.1635E 03	0.1336E 01	0.9477E C3	0.1000E 01
0.9218E 01	0.6439E-01	0.4567E C2	0.4819E-01
0.1734E 02	0.1247E-00	0.8846E 02	0.9334E-01
0.2545E 02	0.1857E-00	0.1317E C3	0.1390E-00
0.3357E 02	0.2474E-00	0.1755E C3	0.1852E-00
0.4169E 02	0.3100E-00	0.2199E C3	0.2320E-00
0.4981E 02	0.3735E-00	0.2649E C3	0.2795E-00
0.5793E 02	0.4377E-00	0.31C4E C3	0.3276E-00
0.6604E 02	0.5027E 00	0.3565E C3	0.3762E-00
0.7416E 02	0.5685E 00	0.4032E C3	0.4255E-00
0.8228E 02	0.6350E 00	0.4504E 03	0.4753E-00
0.9040E 02	0.7C23E 00	0.4981E C3	0.5256E 00
0.9852E 02	0.7703E 00	0.5463E 03	0.5765E 00
0.1066E 03	0.8389E 00	0.5949E C3	0.6278E 00
0.1148E 03	0.9081E 00	0.6441E 03	0.6797E 00
0.1229E 03	0.9780E 00	0.6936E C3	0.732CE 00
0.1310E 03	0.1049E 01	0.7436E C3	0.7847E 00
0.1391E 03	0.1120E 01	0.7941E C3	0.8379E 00
0.1472E 03	0.1191E 01	0.8449E C3	0.8915E 00
0.1553E 03	0.1263E 01	0.8961E C3	0.9456E 00

M=1 FQ= 0.7484E-01 FM= 0.1336E 02 NOPT= 5

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
5	0.5954E 00	0.1679E 01	0.3755E 01	0.1260E-00
4	0.5230E 00	0.1912E 01	0.3824E 01	0.1283E-00
3	0.4214E-00	0.2373E 01	0.4110E 01	0.1379E-00
2	0.2736E-00	0.3655E 01	0.5170E 01	0.1735E-00
1	0.7484E-01	0.1336E 02	0.1336E 02	0.4484E-00

M=2 FQ= 0.2994E-01 FM= 0.3340E 02 NOPT= 7

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
7	0.6058E 00	0.1651E 01	0.4368E 01	0.1466E-00
6	0.5572E 00	0.1795E 01	0.4396E 01	0.1475E-00
5	0.4957E-00	0.2017E 01	0.4511E 01	0.1514E-00
4	0.4160E-00	0.2404E 01	0.4808E 01	0.1613E-00
3	0.3105E-00	0.3221E 01	0.5578E 01	0.1872E-00

M=3 FQ= 0.1497E-01 FM= 0.6681E 02 NOPT= 8

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
8	0.5914E 00	0.1691E 01	0.4782E 01	0.1605E-00
7	0.5487E 00	0.1823E 01	0.4822E 01	0.1618E-00
6	0.4964E-00	0.2014E 01	0.4934E 01	0.1656E-00
5	0.4316E-00	0.2317E 01	0.5181E 01	0.1739E-00
4	0.3498E-00	0.2859E 01	0.5718E 01	0.1919E-00

M=4 FQ= 0.9979E-02 FM= 0.1002E 03 NOPT= 9

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
9	0.5993E 00	0.1668E 01	0.5005E 01	0.1680E-00
8	0.5622E 00	0.1779E 01	0.5031E 01	0.1688E-00
7	0.5178E 00	0.1931E 01	0.5110E 01	0.1715E-00
6	0.4640E-00	0.2155E 01	0.5279E 01	0.1772E-00
5	0.3979E-00	0.2513E 01	0.5619E 01	0.1886E-00

M=5 FQ= 0.7484E-02 FM= 0.1336E 03 NOPT=10

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
10	0.6129E 00	0.1631E 01	0.5159E 01	0.1731E-00
9	0.5805E 00	0.1723E 01	0.5168E 01	0.1734E-00
8	0.5423E 00	0.1844E 01	0.5215E 01	0.1750E-00
7	0.4969E-00	0.2012E 01	0.5324E 01	0.1787E-00
6	0.4423E-00	0.2261E 01	0.5538E 01	0.1859E-00

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---D VENUS-CLOSE
6 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.1635E 03	0.4211E 04	0.
1	0.7293E 02	0.1767E 04	0.2444E 04
2	0.3287E 02	0.7251E 03	0.1042E 04
3	0.1515E 02	0.2944E 03	0.4307E 03
4	0.7315E 01	0.1229E 03	0.1715E 03
5	0.3849E 01	0.5591E 02	0.6703E 02
6	0.2316E 01	0.2870E 02	0.2721E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---D VENUS-CLOSE
8 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.1635E 03	0.4211E 04	0.
1	0.8917E 02	0.2200E 04	0.2011E 04
2	0.4886E 02	0.1135E 04	0.1065E 04
3	0.2700E 02	0.5786E 03	0.5560E 03
4	0.1515E 02	0.2943E 03	0.2844E 03
5	0.8717E 01	0.1520E 03	0.1423E 03
6	0.5231E 01	0.8171E 02	0.7026E 02
7	0.3340E 01	0.4674E 02	0.3496E 02
8	0.2315E 01	0.2869E 02	0.1806E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---D VENUS-CLOSE
10 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.1635E 03	0.4211E 04	0.
1	0.1006E 03	0.2508E 04	0.1703E 04
2	0.6210E 02	0.1481E 04	0.1027E 04
3	0.3849E 02	0.8676E 03	0.6134E 03
4	0.2402E 02	0.5053E 03	0.3623E 03
5	0.1515E 02	0.2943E 03	0.2111E 03
6	0.9708E 01	0.1730E 03	0.1212E 03
7	0.6376E 01	0.1040E 03	0.6897E 02
8	0.4334E 01	0.6481E 02	0.3924E 02
9	0.3082E 01	0.4216E 02	0.2265E 02
10	0.2315E 01	0.2868E 02	0.1347E 02

COMPARISON OF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS BI--1/2.1--H MARS
BON= 0.5200E 01 AON= 0.1338E 01 ECCO= 0.3000E 01
TRANSVERSE ERROR

RN	DELRPN	P	Q
0.3211E 03	0.4966E 01	0.3522E 04	0.1000E 01
0.6716E 02	0.1016E 01	0.7206E 03	0.2046E-00
0.1306E 03	0.1994E 01	0.1414E 04	0.4016E-00
0.1941E 03	0.2980E 01	0.2113E 04	0.6001E 00
0.2576E 03	0.3971E 01	0.2816E 04	0.7996E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.3211E 03	0.3778E-01	0.2679E 02	0.1000E 01
0.6716E 02	0.3536E-01	0.2508E 02	0.9360E 00
0.1306E 03	0.3683E-01	0.2612E 02	0.9750E 00
0.1941E 03	0.3735E-01	0.2649E 02	0.9837E 00
0.2576E 03	0.3762E-01	0.2668E 02	0.9957E 00

VARIATIONS ON PERI-APSIS DISTANCE--MARS
CLASS BI--1/2.1--H
BON= 0.5200E 01 RPERN(1)= 0.3677E 01 DVON= 0.6252E-01

RN	DELRPN	P	Q
0.3211E 03	0.4966E 01	0.3522E 04	0.1000E 01
0.1955E 02	0.2855E-00	0.2025E 03	0.5750E-01
0.3542E 02	0.5298E 00	0.3757E 03	0.1067E-00
0.5129E 02	0.7728E 00	0.5481E 03	0.1556E-00
0.6716E 02	0.1016E 01	0.7206E 03	0.2046E-00
0.8303E 02	0.1260E 01	0.8935E 03	0.2537E-00
0.9890E 02	0.1504E 01	0.1067E 04	0.3029E-00
0.1148E 03	0.1749E 01	0.1240E 04	0.3522E-00
0.1306E 03	0.1994E 01	0.1414E 04	0.4016E-00
0.1465E 03	0.2240E 01	0.1589E 04	0.4511E-00
0.1624E 03	0.2486E 01	0.1763E 04	0.5007E 00
0.1782E 03	0.2733E 01	0.1938E 04	0.5503E 00
0.1941E 03	0.2980E 01	0.2113E 04	0.6001E 00
0.2100E 03	0.3227E 01	0.2289E 04	0.6499E 00
0.2259E 03	0.3475E 01	0.2464E 04	0.6997E 00
0.2417E 03	0.3722E 01	0.2640E 04	0.7496E 00
0.2576E 03	0.3971E 01	0.2816E 04	0.7996E 00
0.2735E 03	0.4219E 01	0.2992E 04	0.8497E 00
0.2893E 03	0.4468E 01	0.3169E 04	0.8997E 00
0.3052E 03	0.4717E 01	0.3345E 04	0.9498E 00

M=1 FQ= 0.5391E 00 FM= 0.1855E 01 NOPT= 1

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
1	0.5391E 00	0.1855E 01	0.1855E 01	0.6225E-01

M=2 FQ= 0.2156E-00 FM= 0.4638E 01 NOPT= 3

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
3	0.5997E 00	0.1668E 01	0.2888E 01	0.9693E-01
2	0.4644E-00	0.2154E 01	0.3046E 01	0.1022E-00
1	0.2156E-00	0.4638E 01	0.4638E 01	0.1556E-00

M=3 FQ= 0.1078E-00 FM= 0.9275E 01 NOPT= 4

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
4	0.5730E 00	0.1745E 01	0.3490E 01	0.1171E-00
3	0.4759E-00	0.2101E 01	0.3639E 01	0.1221E-00
2	0.3283E-00	0.3046E 01	0.4307E 01	0.1445E-00
1	0.1078E-00	0.9275E 01	0.9275E 01	0.3113E-00

M=4 FQ= 0.7188E-01 FM= 0.1391E 02 NOPT= 5

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
5	0.5906E 00	0.1693E 01	0.3786E 01	0.1270E-00
4	0.5178E 00	0.1931E 01	0.3863E 01	0.1296E-00
3	0.4158E-00	0.2405E 01	0.4166E 01	0.1398E-00
2	0.2681E-00	0.3730E 01	0.5275E 01	0.1770E-00
1	0.7188E-01	0.1391E 02	0.1391E 02	0.4669E-00

M=5 FQ= 0.5391E-01 FM= 0.1855E 02 NOPT= 6

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
6	0.6146E 00	0.1627E 01	0.3985E 01	0.1337E-00
5	0.5576E 00	0.1793E 01	0.4010E 01	0.1346E-00
4	0.4818E-00	0.2075E 01	0.4151E 01	0.1393E-00
3	0.3778E-00	0.2647E 01	0.4585E 01	0.1539E-00
2	0.2322E-00	0.4307E 01	0.6091E 01	0.2044E-00

TIME FROM PERI-APSIS IN MINUTES

CLASS BI--1/2,1--H MARS-OPT
2 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.3211E 03	0.6708E 04	0.
1	0.7738E 02	0.1556E 04	0.5152E 04
2	0.2079E 02	0.3866E 03	0.1169E 04

TIME FROM PERI-APSIS IN MINUTES

CLASS BI--1/2,1--H MARS-OPT
4 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.3211E 03	0.6708E 04	0.
1	0.1566E 03	0.3222E 04	0.3485E 04
2	0.7736E 02	0.1555E 04	0.1667E 04
3	0.3918E 02	0.7621E 03	0.7932E 03
4	0.2078E 02	0.3864E 03	0.3757E 03

TIME FROM PERI-APSIS IN MINUTES

CLASS BI--1/2,1--H MARS-OPT
6 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.3211E 03	0.6708E 04	0.
1	0.1988E 03	0.4113E 04	0.2594E 04
2	0.1236E 03	0.2526E 04	0.1588E 04
3	0.7737E 02	0.1555E 04	0.9701E 03
4	0.4897E 02	0.9642E 03	0.5912E 03
5	0.3151E 02	0.6047E 03	0.3594E 03
6	0.2078E 02	0.3865E 03	0.2183E 03

COMPARISON CF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS BI--1/2.1--H MARS
BON= 0.2292E 01 AON= 0.1838E 01 ECCO= 0.1598E 01

TRANSVERSE ERROR

RN	DELRPN	P	Q
0.3211E 03	0.4698E 01	0.3332E C4	0.1000E 01
0.6510E 02	0.8650E 00	0.6135E C3	0.1841E-00
0.1291E 03	0.1784E 01	0.1266E C4	0.3798E-00
0.1931E 03	0.2738E 01	0.1942E 04	0.5829E 00
0.2571E 03	0.3712E 01	0.2633E C4	0.7901E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.3211E 03	0.2158E-01	0.1530E C2	0.1000E 01
0.6510E 02	0.2082E-01	0.1477E C2	0.9649E 00
0.1291E 03	0.2129E-01	0.1510E 02	0.9865E 00
0.1931E 03	0.2145E-01	0.1521E 02	0.9939E 00
0.2571E 03	0.2153E-01	0.1527E C2	0.9977E 00

VARIATIONS CN PERI-APSIS DISTANCE--MARS
CLASS BI--1/2.1--H
BON= 0.2292E C1 RPERN(2)= 0.110CE 01 DVON= C.6995E-C1

RN	DELRPN	P	Q
0.3211E 03	0.4698E 01	0.3332E C4	0.1000E 01
0.1710E 02	0.2156E-00	0.1529E 03	0.4590E-01
0.3310E 02	0.4269E-00	0.3028E C3	0.9088E-01
0.4910E 02	0.6436E 00	0.4565E C3	0.1370E-00
0.6510E 02	0.8650E 00	0.6135E 03	0.1841E-00
0.8110E 02	0.1090E 01	0.7733E 03	0.2321E-00
0.9709E 02	0.1319E 01	0.9354E C3	0.2808E-00
0.1131E 03	0.1550E 01	0.1100E 04	0.3300E-00
0.1291E 03	0.1784E 01	C.1266E 04	0.3798E-00
0.1451E 03	0.2020E 01	0.1433E C4	0.4301E-00
0.1611E 03	0.2258E 01	0.1602E C4	0.4807E-00
0.1771E 03	0.2498E 01	0.1771E 04	0.5316E 00
0.1931E 03	0.2738E 01	0.1942E C4	0.5829E 00
0.2091E 03	0.2980E 01	0.2114E C4	0.6344E 00
0.2251E 03	0.3223E 01	0.2286E C4	0.6861E 00
0.2411E 03	0.3467E 01	0.2459E C4	0.7380E 00
0.2571E 03	0.3712E 01	0.2633E C4	0.7901E 00
0.2731E 03	0.3957E 01	0.2807E C4	0.8424E 00
0.2891E 03	0.4204E 01	0.2981E 04	0.8948E 00
0.3051E 03	0.4450E 01	0.3156E C4	0.9473E 00

M=1 FQ= 0.2129E-01 FM= 0.4698E 02 NOPT= 8

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
8	0.6180E 00	0.1618E 01	0.4576E 01	0.1536E-00
7	0.5770E 00	0.1733E 01	0.4586E 01	0.1539E-00
6	0.5264E 00	0.1900E 01	0.4653E 01	0.1561E-00
5	0.4630E-00	0.2160E 01	0.4829E 01	0.1620E-00
4	0.3820E-00	0.2618E 01	0.5236E 01	0.1757E-00

M=2 FQ= 0.8515E-02 FM= 0.1174E 03 NOPT=10

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
10	0.6209E 00	0.1611E 01	0.5093E 01	0.1709E-00
9	0.5889E 00	0.1698E 01	0.5095E 01	0.1710E-00
8	0.5512E 00	0.1814E 01	0.5132E 01	0.1722E-00
7	0.5062E 00	0.1976E 01	0.5227E 01	0.1754E-00
6	0.4519E-00	0.2213E 01	0.5421E 01	0.1819E-00

M=3 FQ= 0.4257E-02 FM= 0.2349E 03 NOPT=11

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
11	0.6088E 00	0.1643E 01	0.5448E 01	0.1828E-00
10	0.5793E 00	0.1726E 01	0.5459E 01	0.1832E-00
9	0.5452E 00	0.1834E 01	0.5502E 01	0.1846E-00
8	0.5054E 00	0.1979E 01	0.5596E 01	0.1878E-00
7	0.4585E-00	0.2181E 01	0.5771E 01	0.1937E-00

M=4 FQ= 0.2838E-02 FM= 0.3523E 03 NOPT=12

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
12	0.6134E 00	0.1630E 01	0.5647E 01	0.1895E-00
11	0.5868E 00	0.1704E 01	0.5652E 01	0.1897E-00
10	0.5563E 00	0.1798E 01	0.5685E 01	0.1908E-00
9	0.5212E 00	0.1919E 01	0.5756E 01	0.1932E-00
8	0.4804E-00	0.2081E 01	0.5887E 01	0.1976E-00

M=5 FQ= 0.2129E-02 FM= 0.4698E 03 NOPT=12

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
12	0.5989E 00	0.1670E 01	0.5784E 01	0.1941E-00
11	0.5716E 00	0.1749E 01	0.5802E 01	0.1947E 00
10	0.5405E 00	0.1850E 01	0.5850E 01	0.1963E-00
9	0.5048E 00	0.1981E 01	0.5943E 01	0.1994E-00
8	0.4635E-00	0.2158E 01	0.6103E 01	0.2048E-00

TIME FROM PERI-APSIS IN MINUTES

CLASS BI--1/2,1--H MARS-CLOSE
8 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.3211E 03	0.6684E 04	0.
1	0.1494E 03	0.3047E 04	0.3636E 04
2	0.6985E 02	0.1377E 04	0.1670E 04
3	0.3296E 02	0.6163E 03	0.7605E 03
4	0.1587E 02	0.2754E 03	0.3409E 03
5	0.7945E 01	0.1258E 03	0.1497E 03
6	0.4273E 01	0.6096E 02	0.6479E 02
7	0.2571E 01	0.3239E 02	0.2856E 02
8	0.1782E 01	0.1891E 02	0.1349E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS BI--1/2,1--H MARS-CLOSE
10 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.3211E 03	0.6684E 04	0.
1	0.1741E 03	0.3568E 04	0.3116E 04
2	0.9458E 02	0.1894E 04	0.1674E 04
3	0.5163E 02	0.9989E 03	0.8948E 03
4	0.2841E 02	0.5242E 03	0.4747E 03
5	0.1586E 02	0.2753E 03	0.2489E 03
6	0.9079E 01	0.1465E 03	0.1288E 03
7	0.5412E 01	0.8059E 02	0.6591E 02
8	0.3431E 01	0.4675E 02	0.3385E 02
9	0.2360E 01	0.2887E 02	0.1788E 02
10	0.1781E 01	0.1889E 02	0.9971E 01

TIME FROM PERI-APSIS IN MINUTES

CLASS BI--1/2,1--H MARS-CLOSE
12 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.3211E 03	0.6684E 04	0.
1	0.1927E 03	0.3963E 04	0.2721E 04
2	0.1159E 03	0.2341E 04	0.1622E 04
3	0.6984E 02	0.1377E 04	0.9640E 03
4	0.4227E 02	0.8062E 03	0.5704E 03
5	0.2576E 02	0.4708E 03	0.3354E 03
6	0.1587E 02	0.2754E 03	0.1955E 03
7	0.9944E 01	0.1625E 03	0.1128E 03
8	0.6396E 01	0.9791E 02	0.6462E 02
9	0.4272E 01	0.6094E 02	0.3697E 02
10	0.3000E 01	0.3955E 02	0.2140E 02
11	0.2238E 01	0.2681E 02	0.1274E 02
12	0.1781E 01	0.1890E 02	0.7906E 01

VARIATIONS CN PERI-APSIS DISTANCE--MARS
CLASS IN---C.C---A
BCN= 0.7775E CO RPERN(1)= 0.5498E OC DVON= C.1617E-00

COMPARISON CF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS IN---0.0---A MARS
BCN= 0.1347E 01 AON= 0.2749E-00 ECCO= 0.5002E 01
TRANSVERSE ERROR

RN	DELRPN	P	Q
0.3211E 03	0.1963E 01	0.1392E C4	0.1000E 01
0.6510E 02	0.3950E-00	0.2801E C3	0.2012E-00
0.1291E 03	0.7857E 00	0.5573E C3	0.4002E-00
0.1931E 03	0.1178E 01	0.8352E C3	0.5998E 00
0.2571E 03	0.1570E 01	0.1114E C4	0.7998E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.3211E 03	0.2680E-02	0.19C1E C1	0.1000E 01
0.6510E 02	0.2635E-02	0.1869E C1	0.9832E 00
0.1291E 03	0.2663E-02	0.1888E C1	0.9936E 00
0.1931E 03	0.2672E-02	0.1895E C1	0.9972E 00
0.2571E 03	0.2677E-02	0.1898E C1	0.9989E 00

VARIATIONS CN PERI-APSIS DISTANCE--MARS
CLASS IN---0.0---A
BCN= 0.1347E C1 RPERN(2)= 0.11C0E 01 DVON= 0.1657E-00

RN	DELRPN	P	Q
0.3211E 03	0.1963E 01	0.1392E C4	0.1000E 01
0.1710E 02	0.1C31E-00	0.7314E C2	0.5253E-01
0.3310E 02	0.2C03E-00	0.1421E 03	0.1020E-00
0.4910E 02	0.2976E-00	0.2111E C3	0.1516E-00
0.6510E 02	0.3950E-00	0.2801E C3	0.2012E-00
0.8110E 02	0.4925E-00	0.3493E C3	0.2509E-00
0.9709E 02	0.5902E 00	0.4186E C3	0.3006E-00
0.1131E 03	0.6879E 00	0.4879E C3	0.3504E-00
0.1291E 03	0.7857E 00	0.5573E C3	0.4002E-00
0.1451E 03	0.8836E 00	0.6267E C3	0.4501E-00
0.1611E 03	0.9816E 00	0.6962E C3	0.4999E-00
0.1771E 03	0.1C80E 01	0.7657E C3	0.5499E 00
0.1931E 03	0.1178E 01	0.8352E C3	0.5998E 00
0.2C91E 03	0.1276E 01	0.9048E C3	0.6498E 00
0.2251E 03	0.1374E 01	0.9744E C3	0.6998E 00
0.2411E 03	0.1472E 01	0.1044E C4	0.7498E 00
0.2571E 03	0.1570E 01	0.1114E C4	0.7998E 00
0.2731E 03	0.1669E 01	0.1183E C4	0.8498E 00
0.2891E 03	0.1767E 01	0.1253E C4	0.8999E 00
0.3051E 03	0.1865E 01	C.1323E C4	0.9499E 00

M=1 FQ= 0.5093E-01 FM= 0.1963E 02 NOPT= 6

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
6	0.6088E 00	0.1642E 01	0.4023E 01	0.1350E-00
5	0.5513E 00	0.1814E 01	0.4056E 01	0.1361E-00
4	0.4751E-00	0.2105E 01	0.4210E 01	0.1413E-00
3	0.3707E-00	0.2698E 01	0.4673E 01	0.1568E-00
2	0.2257E-00	0.4431E 01	0.6266E 01	0.2103E-00

M=2 FQ= 0.2037E-01 FM= 0.4908E 02 NOPT= 8

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
8	0.6147E 00	0.1627E 01	0.4602E 01	0.1544E-00
7	0.5734E 00	0.1744E 01	0.4614E 01	0.1548E-00
6	0.5226E 00	0.1913E 01	0.4687E 01	0.1573E-00
5	0.4590E-00	0.2179E 01	0.4872E 01	0.1635E-00
4	0.3778E-00	0.2647E 01	0.5294E 01	0.1776E-00

M=3 FQ= 0.1019E-01 FM= 0.9817E 02 NOPT= 9

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
9	0.6007E 00	0.1665E 01	0.4994E 01	0.1676E-00
8	0.5636E 00	0.1774E 01	0.5018E 01	0.1684E-00
7	0.5193E 00	0.1926E 01	0.5095E 01	0.1710E-00
6	0.4656E-00	0.2148E 01	0.5261E 01	0.1765E-00
5	0.3996E-00	0.2503E 01	0.5596E 01	0.1878E-00

M=4 FQ= 0.6791E-02 FM= 0.1473E 03 NOPT=10

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
10	0.6070E 00	0.1647E 01	0.5210E 01	0.1748E-00
9	0.5743E 00	0.1741E 01	0.5224E 01	0.1753E-00
8	0.5358E 00	0.1866E 01	0.5279E 01	0.1771E-00
7	0.4901E-00	0.2040E 01	0.5398E 01	0.1812E-00
6	0.4352E-00	0.2298E 01	0.5629E 01	0.1889E-00

M=5 FQ= 0.5093E-02 FM= 0.1963E 03 NOPT=11

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
11	0.6188E 00	0.1616E 01	0.5360E 01	0.1799E-00
10	0.5898E 00	0.1696E 01	0.5362E 01	0.1799E-00
9	0.5562E 00	0.1798E 01	0.5394E 01	0.1810E-00
8	0.5169E 00	0.1935E 01	0.5472E 01	0.1836E-00
7	0.4704E-00	0.2126E 01	0.5625E 01	0.1888E-00

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---A MARS-CLOSE

7 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.3211E 03	0.2640E 04	0.
1	0.1516E 03	0.1242E 04	0.1398E 04
2	0.7191E 02	0.5854E 03	0.6567E 03
3	0.3441E 02	0.2773E 03	0.3081E 03
4	0.1677E 02	0.1330E 03	0.1443E 03
5	0.8470E 01	0.6556E 02	0.6744E 02
6	0.4567E 01	0.3395E 02	0.3161E 02
7	0.2731E 01	0.1885E 02	0.1510E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---A MARS-CLOSE

9 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.3211E 03	0.2640E 04	0.
1	0.1791E 03	0.1468E 04	0.1171E 04
2	0.1001E 03	0.8174E 03	0.6510E 03
3	0.5616E 02	0.4559E 03	0.3615E 03
4	0.3172E 02	0.2553E 03	0.2006E 03
5	0.1813E 02	0.1441E 03	0.1112E 03
6	0.1057E 02	0.8261E 02	0.6152E 02
7	0.6369E 01	0.4855E 02	0.3406E 02
8	0.4031E 01	0.2959E 02	0.1897E 02
9	0.2730E 01	0.1885E 02	0.1074E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---A MARS-CLOSE

11 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.3211E 03	0.2640E 04	0.
1	0.1991E 03	0.1634E 04	0.1006E 04
2	0.1236E 03	0.1011E 04	0.6223E 03
3	0.7692E 02	0.6267E 03	0.3847E 03
4	0.4802E 02	0.3890E 03	0.2377E 03
5	0.3013E 02	0.2422E 03	0.1467E 03
6	0.1907E 02	0.1517E 03	0.9051E 02
7	0.1222E 02	0.9596E 02	0.5578E 02
8	0.7979E 01	0.6158E 02	0.3437E 02
9	0.5357E 01	0.4036E 02	0.2122E 02
10	0.3734E 01	0.2717E 02	0.1319E 02
11	0.2730E 01	0.1885E 02	0.8320E 01

VARIATIONS CN PERI-APSIS DISTANCE--MARS
CLASS IN---0.0---B
BCN= 0.3549E-C0 RPERN(1)= 0.2509E-0C DVON= 0.2393E-00

COMPARISON CF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS IN---0.0---B MARS
BON= 0.1219E C1 AON= 0.1255E-00 ECCO= 0.9767E 01
TRANSVERSE ERROR

RN	DELRPN	P	Q
0.3211E 03	0.1334E 01	0.9462E C3	0.1000E 01
0.6510E 02	0.2700E-00	0.1915E 03	0.2023E-00
0.1291E 03	0.5358E 00	0.3800E C3	0.4016E-00
0.1931E 03	0.8018E 00	0.5687E C3	0.6010E 00
0.2571E 03	0.1068E 01	0.7574E C3	0.8004E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.3211E 03	0.9323E-03	0.6612E C0	0.1000E 01
0.6510E 02	0.9153E-03	0.6492E C0	0.9819E 00
0.1291E 03	0.9241E-03	0.6554E C0	0.9912E 00
0.1931E 03	0.9270E-03	0.6574E 00	0.9944E 00
0.2571E 03	0.9285E-03	0.6585E C0	0.9959E 00

VARIATIONS CN PERI-APSIS DISTANCE--MARS
CLASS IN---0.0---B
BON= 0.1219E C1 RPERN(2)= 0.110CE 01 DVON= 0.2608E-C0

RN	DELRPN	P	Q
0.3211E 03	0.1334E 01	0.9462E C3	0.1000E 01
0.1710E 02	0.7069E-01	0.5014E C2	0.5298E-01
0.3310E 02	0.1371E-00	0.9726E C2	0.1028E-00
0.4910E 02	0.2035E-00	0.1444E C3	0.1526E-00
0.6510E 02	0.2700E-00	0.1915E C3	0.2023E-00
0.8110E 02	0.3364E-C0	0.2386E C3	0.2521E-00
0.9709E 02	0.4028E-00	0.2857E C3	0.3019E-00
0.1131E 03	0.4693E-00	0.3328E C3	0.3518E-00
0.1291E 03	0.5358E 00	0.3800E C3	0.4016E-00
0.1451E 03	0.6023E C0	0.4271E 03	0.4514E-00
0.1611E 03	0.6688E C0	0.4743E C3	0.5013E 00
0.1771E 03	0.7353E 00	0.5215E C3	0.5511E 00
0.1931E 03	0.8018E 00	0.5687E 03	0.6010E 00
0.2091E 03	0.8683E 00	0.6158E C3	0.6508E 00
0.2251E 03	0.9349E 00	0.6630E C3	0.7007E 00
0.2411E 03	0.1001E 01	0.7102E C3	0.7506E 00
0.2571E 03	0.1068E 01	0.7574E C3	0.8004E 00
0.2731E 03	0.1135E 01	0.8046E C3	0.8503E 00
0.2891E 03	0.1201E 01	0.8518E C3	0.9002E 00
0.3051E 03	0.1268E 01	0.8990E C3	0.9501E 00

M=1 FQ= 0.7495E-01 FM= 0.1334E 02 NOPT= 5

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
5	0.5956E 00	0.1679E 01	0.3754E 01	0.1260E-00
4	0.5232E 00	0.1911E 01	0.3822E 01	0.1283E-00
3	0.4216E-00	0.2372E 01	0.4108E 01	0.1379E-00
2	0.2738E-00	0.3653E 01	0.5166E 01	0.1733E-00
1	0.7495E-01	0.1334E 02	0.1334E 02	0.4477E-00

M=2 FQ= 0.2998E-01 FM= 0.3336E 02 NOPT= 7

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
7	0.6059E 00	0.1650E 01	0.4367E 01	0.1465E-00
6	0.5574E 00	0.1794E 01	0.4395E 01	0.1475E-00
5	0.4959E-00	0.2017E 01	0.4509E 01	0.1513E-00
4	0.4161E-00	0.2403E 01	0.4806E 01	0.1613E-00
3	0.3107E-00	0.3219E 01	0.5575E 01	0.1871E-00

M=3 FQ= 0.1499E-01 FM= 0.6671E 02 NOPT= 8

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
8	0.5915E 00	0.1691E 01	0.4782E 01	0.1605E-00
7	0.5488E 00	0.1822E 01	0.4821E 01	0.1618E-00
6	0.4966E-00	0.2014E 01	0.4933E 01	0.1655E-00
5	0.4317E-00	0.2317E 01	0.5180E 01	0.1738E-00
4	0.3499E-00	0.2858E 01	0.5716E 01	0.1918E-00

M=4 FQ= 0.9993E-02 FM= 0.1001E 03 NOPT= 9

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
9	0.5994E 00	0.1668E 01	0.5005E 01	0.1679E-00
8	0.5623E 00	0.1778E 01	0.5030E 01	0.1688E-00
7	0.5179E 00	0.1931E 01	0.5109E 01	0.1714E-00
6	0.4641E-00	0.2155E 01	0.5278E 01	0.1771E-00
5	0.3981E-00	0.2512E 01	0.5617E 01	0.1885E-00

M=5 FQ= 0.7495E-02 FM= 0.1334E 03 NOPT=10

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
10	0.6130E 00	0.1631E 01	0.5158E 01	0.1731E-00
9	0.5806E 00	0.1722E 01	0.5167E 01	0.1734E-00
8	0.5424E 00	0.1844E 01	0.5214E 01	0.1750E-00
7	0.4970E-00	0.2012E 01	0.5323E 01	0.1786E-00
6	0.4424E-00	0.2260E 01	0.5537E 01	0.1858E-00

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---B MARS-CLOSE
6 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.3211E 03	0.1788E 04	0.
1	0.1427E 03	0.7929E 03	0.9950E 03
2	0.6373E 02	0.3530E 03	0.4399E 03
3	0.2881E 02	0.1586E 03	0.1944E 03
4	0.1336E 02	0.7276E 02	0.8583E 02
5	0.6523E 01	0.3480E 02	0.3796E 02
6	0.3499E 01	0.1781E 02	0.1699E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---B MARS-CLOSE
8 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.3211E 03	0.1788E 04	0.
1	0.1747E 03	0.9713E 03	0.8166E 03
2	0.9524E 02	0.5285E 03	0.4427E 03
3	0.5216E 02	0.2886E 03	0.2400E 03
4	0.2880E 02	0.1585E 03	0.1300E 03
5	0.1612E 02	0.8810E 02	0.7042E 02
6	0.9248E 01	0.4995E 02	0.3816E 02
7	0.5520E 01	0.2920E 02	0.2075E 02
8	0.3497E 01	0.1780E 02	0.1140E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---B MARS-CLOSE
10 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.3211E 03	0.1788E 04	0.
1	0.1973E 03	0.1097E 04	0.6906E 03
2	0.1213E 03	0.6740E 03	0.4232E 03
3	0.7481E 02	0.4147E 03	0.2593E 03
4	0.4628E 02	0.2558E 03	0.1589E 03
5	0.2880E 02	0.1585E 03	0.9729E 02
6	0.1808E 02	0.9897E 02	0.5957E 02
7	0.1151E 02	0.6249E 02	0.3648E 02
8	0.7480E 01	0.4012E 02	0.2237E 02
9	0.5011E 01	0.2635E 02	0.1377E 02
10	0.3497E 01	0.1780E 02	0.8554E 01

VARIATIONS ON PERI-APSIS DISTANCE--MARS
CLASS IN---C.0---C
BON= 0.1115E-C0 RPERN(1)= 0.7881E-01 DVON= C.4271E-00

COMPARISON CF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS IN---C.0---C MARS
BON= 0.1139E C1 AON= 0.3940E-01 ECCC= 0.2892E 02
TRANSVERSE ERROR

RN	DELRPN	P	Q
0.3211E 03	0.7493E 00	0.5314E C3	0.1000E 01
0.6510E 02	0.1519E-00	0.1077E C3	0.2027E-00
0.1291E 03	0.3012E-00	0.2136E C3	0.4020E-00
0.1931E 03	0.4506E-00	0.3196E C3	0.6013E 00
0.2571E 03	0.5999E 00	0.4255E C3	0.8007E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.3211E 03	0.1787E-03	0.1268E-C0	0.1000E 01
0.6510E 02	0.1739E-03	0.1233E-C0	0.9729E 00
0.1291E 03	0.1754E-03	0.1244E-C0	0.9813E 00
0.1931E 03	0.1759E-03	0.1248E-C0	0.9842E 00
0.2571E 03	0.1762E-03	0.1250E-C0	0.9857E 00

VARIATIONS CN PERI-APSIS DISTANCE--MARS
CLASS IN---0.0---C
BON= 0.1139E C1 RPERN(2)= 0.110CE 01 DVON= 0.5109E 00

RN	DELRPN	P	Q
0.3211E 03	0.7493E 00	0.5314E C3	0.1000E 01
0.1710E 02	0.3981E-01	0.2823E C2	0.5312E-01
0.3310E 02	0.7718E-01	0.5474E C2	0.1030E-00
0.4910E 02	0.1145E-00	0.8122E C2	0.1528E-00
0.6510E 02	0.1519E-00	0.1077E C3	0.2027E-00
0.8110E 02	0.1892E-00	0.1342E C3	0.2525E-00
0.9709E 02	0.2265E-00	0.1607E C3	0.3023E-00
0.1131E 03	0.2639E-00	0.1872E C3	0.3522E-00
0.1291E 03	0.3012E-00	0.2136E C3	0.4020E-00
0.1451E 03	0.3386E-00	0.2401E C3	0.4518E-00
0.1611E 03	0.3759E-00	0.2666E C3	0.5017E 00
0.1771E 03	0.4132E-00	0.2931E C3	0.5515E 00
0.1931E 03	0.4506E-00	0.3196E C3	0.6013E 00
0.2091E 03	0.4879E-00	0.3460E C3	0.6512E 00
0.2251E 03	0.5253E 00	0.3725E C3	0.7010E 00
0.2411E 03	0.5626E 00	0.3990E C3	0.7508E 00
0.2571E 03	0.5999E 00	0.4255E C3	0.8007E 00
0.2731E 03	0.6373E 00	0.4520E C3	0.8505E 00
0.2891E 03	0.6746E 00	0.4785E C3	0.9003E 00
0.3051E 03	0.7120E 00	0.5049E C3	0.9502E 00

M=1 FQ= 0.1335E-00 FM= 0.7493E 01 NOPT= 4

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
4	0.6044E 00	0.1655E 01	0.3309E 01	0.1110E-00
3	0.5110E 00	0.1957E 01	0.3389E 01	0.1137E-00
2	0.3653E-00	0.2737E 01	0.3871E 01	0.1299E-00
1	0.1335E-00	0.7493E 01	0.7493E 01	0.2514E-00

M=2 FQ= 0.5338E-01 FM= 0.1873E 02 NOPT= 6

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
6	0.6136E 00	0.1630E 01	0.3992E 01	0.1340E-00
5	0.5565E 00	0.1797E 01	0.4018E 01	0.1348E-00
4	0.4807E-00	0.2080E 01	0.4161E 01	0.1396E-00
3	0.3765E-00	0.2656E 01	0.4600E 01	0.1544E-00
2	0.2310E-00	0.4328E 01	0.6121E 01	0.2054E-00

M=3 FQ= 0.2669E-01 FM= 0.3747E 02 NOPT= 7

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
7	0.5959E 00	0.1678E 01	0.4440E 01	0.1490E-00
6	0.5467E 00	0.1829E 01	0.4481E 01	0.1504E-00
5	0.4845E-00	0.2064E 01	0.4615E 01	0.1549E-00
4	0.4042E-00	0.2474E 01	0.4948E 01	0.1660E-00
3	0.2989E-00	0.3346E 01	0.5796E 01	0.1945E-00

M=4 FQ= 0.1779E-01 FM= 0.5620E 02 NOPT= 8

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
8	0.6043E 00	0.1655E 01	0.4680E 01	0.1571E-00
7	0.5624E 00	0.1778E 01	0.4704E 01	0.1579E-00
6	0.5110E 00	0.1957E 01	0.4794E 01	0.1609E-00
5	0.4467E-00	0.2238E 01	0.5005E 01	0.1680E-00
4	0.3652E-00	0.2738E 01	0.5476E 01	0.1838E-00

M=5 FQ= 0.1335E-01 FM= 0.7493E 02 NOPT= 9

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
9	0.6190E 00	0.1615E 01	0.4846E 01	0.1626E-00
8	0.5830E 00	0.1715E 01	0.4852E 01	0.1628E-00
7	0.5397E 00	0.1853E 01	0.4902E 01	0.1645E-00
6	0.4870E-00	0.2053E 01	0.5029E 01	0.1688E-00
5	0.4218E-00	0.2371E 01	0.5302E 01	0.1779E-00

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---C MARS-CLOSE
5 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.3211E 03	0.1003E 04	0.
1	0.1361E 03	0.4248E 03	0.5783E 03
2	0.5803E 02	0.1809E 03	0.2439E 03
3	0.2511E 02	0.7809E 02	0.1029E 03
4	0.1123E 02	0.3468E 02	0.4341E 02
5	0.5373E 01	0.1626E 02	0.1842E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---C MARS-CLOSE
7 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.3211E 03	0.1003E 04	0.
1	0.1738E 03	0.5428E 03	0.4604E 03
2	0.9431E 02	0.2943E 03	0.2485E 03
3	0.5140E 02	0.1602E 03	0.1341E 03
4	0.2825E 02	0.8788E 02	0.7235E 02
5	0.1575E 02	0.4883E 02	0.3905E 02
6	0.9008E 01	0.2772E 02	0.2111E 02
7	0.5368E 01	0.1625E 02	0.1147E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---C MARS-CLOSE
9 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.3211E 03	0.1003E 04	0.
1	0.1992E 03	0.6221E 03	0.3811E 03
2	0.1237E 03	0.3862E 03	0.2359E 03
3	0.7700E 02	0.2402E 03	0.1460E 03
4	0.4808E 02	0.1498E 03	0.9036E 02
5	0.3018E 02	0.9392E 02	0.5593E 02
6	0.1910E 02	0.5930E 02	0.3462E 02
7	0.1224E 02	0.3785E 02	0.2145E 02
8	0.7997E 01	0.2455E 02	0.1331E 02
9	0.5369E 01	0.1625E 02	0.8291E 01

COMPARISON CF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS BI--1/2.1--H VENUS, RETURN
BON= 0.3020E 02 AON= 0.1068E 02 ECCO= 0.3000E 01
TRANSVERSE ERROR

RN	DELRPN	P	Q
0.2347E 03	0.3832E 01	0.2718E C4	0.1000E 01
0.6402E 02	0.9552E 00	0.6774E C3	0.2493E-00
0.1067E 03	0.1689E 01	0.1198E 04	0.4407E-00
0.1494E 03	0.2407E 01	0.17C7E C4	0.6281E 00
0.1920E 03	0.3120E 01	0.2213E C4	0.8142E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.2347E 03	0.2108E-00	0.1495E C3	0.1000E 01
0.6402E 02	0.1395E-00	0.9894E C2	0.6617E 00
0.1067E 03	0.1767E-00	0.1253E C3	0.8381E 00
0.1494E 03	0.1941E-00	0.1377E C3	0.9207E 00
0.1920E 03	0.2042E-00	0.1448E C3	0.9686E 00

VARIATIONS CN PERI-APSIS DISTANCE--VENUS,RETURN
CLASS BI--1/2.1--H
BON= 0.3020E C2 RPERN(1)= 0.2135E 02 DVON= 0.5748E-01

RN	DELRPN	P	Q
0.2347E 03	0.3832E 01	0.2718E C4	0.1000E 01
0.3202E 02	0.3557E-00	0.2523E C3	0.9283E-01
0.4269E 02	0.5683E 00	C.4031E C3	0.1483E-00
0.5335E 02	0.7652E 00	0.5427E C3	0.1997E-00
0.6402E 02	0.9552E 00	0.6774E C3	0.2493E-00
0.7469E 02	0.1141E 01	0.8095E C3	0.2979E-00
0.8535E 02	0.1325E 01	0.9399E C3	0.3458E-00
0.9602E 02	0.1507E 01	0.1C69E C4	0.3934E-00
0.1067E 03	0.1689E 01	0.1198E C4	0.4407E-00
0.1174E 03	0.1869E 01	0.1325E C4	0.4877E-00
0.1280E 03	0.2049E 01	0.1453E C4	0.5346E 00
0.1387E 03	0.2228E 01	0.1580E C4	0.5814E 00
0.1494E 03	0.2407E 01	0.17C7E C4	0.6281E 00
0.1600E 03	0.2585E 01	0.1833E C4	0.6747E 00
0.1707E 03	0.2764E 01	0.1960E C4	0.7212E 00
0.1814E 03	0.2942E 01	C.2086E C4	0.7678E 00
0.1920E 03	0.3120E 01	0.2213E C4	0.8142E 00
0.2027E 03	0.3298E 01	0.2339E C4	0.8607E 00
0.2134E 03	0.3476E 01	0.2465E C4	0.9071E 00
0.2240E 03	0.3654E 01	0.2591E C4	0.9536E 00

```
M=4  FQ= 0.7082E 00      FM= 0.1412E 01      NOPT= 1
 N   RED. FACTOR      MULT.FACTOR    SUM/W             SUM/29.8
 1    0.7082E 00      0.1412E 01     0.1412E 01       0.4738E-01

M=5  FQ= 0.5311E 00      FM= 0.1883E 01      NOPT= 1
 N   RED. FACTOR      MULT.FACTOR    SUM/W             SUM/29.8
 1    0.5311E 00      0.1883E 01     0.1883E 01       0.6318E-01



TIME FROM PERI-APSIS IN MINUTES

CLASS   BI--1/2,1--H      VENUS-OPT-RETURN
 1  CORRECTION STEPS
 N      RANGE            TIME           DELTA-TIME
 0   0.2347E 03      0.9389E 04      0.
 1   0.1347E 03      0.5188E 04      0.4201E 04
```

COMPARISON OF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS BI--1/2.1--H VENUS, RETURN
BON= 0.4851E 01 AON= 0.1068E 02 ECCC= 0.1098E 01

TRANSVERSE ERROR

RN	DELRPN	P	Q
0.2347E 03	0.2186E 01	0.1551E C4	0.1000E 01
0.4778E 02	0.3650E-00	0.2589E C3	0.1669E-00
0.9451E 02	0.7667E 00	0.5437E C3	0.3507E-00
0.1412E 03	0.1206E 01	0.8557E C3	0.5518E 00
C.1880E 03	0.1681E 01	0.1192E C4	0.7688E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.2347E 03	0.3173E-01	0.2250E C2	0.1000E 01
0.4778E 02	0.2703E-01	0.1917E C2	0.8519E 00
0.9451E 02	0.2972E-01	0.2108E C2	0.9365E 00
C.1412E 03	0.3079E-01	0.2184E C2	0.9703E 00
0.1880E 03	0.3137E-01	0.2225E C2	0.9886E 00

VARIATIONS CN PERI-APSIS DISTANCE--VENUS,RETURN
CLASS BI--1/2.1--H
BON= 0.4851E C1 RPERN(2)= 0.105CE 01 DVON= C.1163E-00

RN	DELRPN	P	Q
0.2347E 03	0.2186E 01	0.1551E C4	0.1000E 01
0.1273E 02	0.9C45E-C1	0.6415E C2	0.4137E-01
0.2441E 02	0.1794E-00	C.1273E C3	0.8207E-01
0.3610E 02	0.2709E-00	0.1921E C3	0.1239E-00
0.4778E 02	0.3650E-00	0.2589E C3	0.1669E-00
0.5946E 02	0.4616E-00	0.3274E C3	0.2112E-00
0.7114E 02	0.5608E C0	0.3978E C3	0.2565E-00
0.8283E 02	0.6625E 00	0.4699E C3	0.3030E-00
0.9451E 02	0.7667E 00	0.5437E C3	0.3507E-00
0.1062E 03	0.8732E 00	0.6193E C3	0.3994E-00
0.1179E 03	0.9820E 00	0.6965E C3	0.4492E-00
0.1296E 03	0.1C93E 01	0.7753E C3	0.5000E 00
0.1412E 03	0.1206E 01	0.8557E C3	0.5518E 00
0.1529E 03	0.1322E 01	0.9376E C3	0.6047E 00
0.1646E 03	0.1440E 01	0.1021E C4	0.6585E 00
0.1763E 03	0.1559E 01	0.11C6E C4	0.7132E 00
0.1880E 03	0.1681E 01	C.1192E C4	0.7688E 00
0.1996E 03	0.1804E 01	C.1280E C4	0.8253E 00
0.2113E 03	0.1930E 01	0.1369E C4	0.8827E 00
0.2230E 03	0.2057E 01	0.1459E C4	0.9410E 00

M=1 FQ= 0.2298E-01 FM= 0.4352E 02 NOPT= 8

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
8	0.6240E 00	0.1603E 01	0.4533E 01	0.1521E-00
7	0.5833E 00	0.1714E 01	0.4536E 01	0.1522E-00
6	0.5332E 00	0.1875E 01	0.4594E 01	0.1542E-00
5	0.4702E-00	0.2127E 01	0.4756E 01	0.1596E-00
4	0.3893E-00	0.2568E 01	0.5137E 01	0.1724E-00

M=2 FQ= 0.9191E-02 FM= 0.1088E 03 NOPT= 9

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
9	0.5939E 00	0.1684E 01	0.5051E 01	0.1695E-00
8	0.5564E 00	0.1797E 01	0.5083E 01	0.1706E-00
7	0.5117E 00	0.1954E 01	0.5170E 01	0.1735E-00
6	0.4577E-00	0.2185E 01	0.5352E 01	0.1796E-00
5	0.3914E-00	0.2555E 01	0.5712E 01	0.1917E-00

M=3 FQ= 0.4596E-02 FM= 0.2176E 03 NOPT=11

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
11	0.6130E 00	0.1631E 01	0.5410E 01	0.1815E-00
10	0.5838E 00	0.1713E 01	0.5417E 01	0.1818E-00
9	0.5499E 00	0.1819E 01	0.5456E 01	0.1831E-00
8	0.5103E 00	0.1960E 01	0.5543E 01	0.1860E-00
7	0.4635E-00	0.2158E 01	0.5708E 01	0.1916E-00

M=4 FQ= 0.3064E-02 FM= 0.3264E 03 NOPT=12

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
12	0.6173E 00	0.1620E 01	0.5611E 01	0.1883E-00
11	0.5909E 00	0.1692E 01	0.5613E 01	0.1884E-00
10	0.5606E 00	0.1784E 01	0.5641E 01	0.1893E-00
9	0.5256E 00	0.1902E 01	0.5707E 01	0.1915E-00
8	0.4850E-00	0.2062E 01	0.5831E 01	0.1957E-00

M=5 FQ= 0.2298E-02 FM= 0.4352E 03 NOPT=12

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
12	0.6027E 00	0.1659E 01	0.5748E 01	0.1929E-00
11	0.5756E 00	0.1737E 01	0.5762E 01	0.1934E-00
10	0.5447E 00	0.1836E 01	0.5806E 01	0.1948E-00
9	0.5091E 00	0.1964E 01	0.5893E 01	0.1977E-00
8	0.4679E-00	0.2137E 01	0.6045E 01	0.2028E-00

TIME FROM PERI-APSIS IN MINUTES

CLASS BI--1/2,1--H VENUS-CLOSE-RETURN
8 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.8997E 04	0.
1	0.1104E 03	0.3866E 04	0.5131E 04
2	0.5220E 02	0.1602E 04	0.2264E 04
3	0.2498E 02	0.6445E 03	0.9572E 03
4	0.1225E 02	0.2594E 03	0.3850E 03
5	0.6290E 01	0.1100E 03	0.1494E 03
6	0.3502E 01	0.5172E 02	0.5830E 02
7	0.2197E 01	0.2750E 02	0.2422E 02
8	0.1587E 01	0.1625E 02	0.1125E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS BI--1/2,1--H VENUS-CLOSE-RETURN
10 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.8997E 04	0.
1	0.1283E 03	0.4590E 04	0.4406E 04
2	0.7037E 02	0.2289E 04	0.2302E 04
3	0.3881E 02	0.1116E 04	0.1173E 04
4	0.2162E 02	0.5367E 03	0.5792E 03
5	0.1225E 02	0.2596E 03	0.2771E 03
6	0.7153E 01	0.1298E 03	0.1298E 03
7	0.4374E 01	0.6897E 02	0.6081E 02
8	0.2861E 01	0.3962E 02	0.2936E 02
9	0.2036E 01	0.2459E 02	0.1503E 02
10	0.1587E 01	0.1626E 02	0.8326E 01

TIME FROM PERI-APSIS IN MINUTES

CLASS BI--1/2,1--H VENUS-CLOSE-RETURN
12 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.8997E 04	0.
1	0.1419E 03	0.5143E 04	0.3854E 04
2	0.8592E 02	0.2894E 04	0.2249E 04
3	0.5220E 02	0.1602E 04	0.1292E 04
4	0.3188E 02	0.8746E 03	0.7270E 03
5	0.1963E 02	0.4748E 03	0.3999E 03
6	0.1225E 02	0.2594E 03	0.2153E 03
7	0.7800E 01	0.1451E 03	0.1144E 03
8	0.5118E 01	0.8442E 02	0.6067E 02
9	0.3502E 01	0.5172E 02	0.3270E 02
10	0.2528E 01	0.3350E 02	0.1822E 02
11	0.1941E 01	0.2285E 02	0.1065E 02
12	0.1587E 01	0.1625E 02	0.6595E 01

COMPARISON OF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS EX---C.0---A VENUS, RETURN
BON= 0.5564E C1 AON= 0.1967E 01 ECCO= 0.3000E 01
TRANSVERSE ERROR

RN	DELRPN	P	Q
0.2347E 03	0.1669E 01	0.1184E C4	0.1000E 01
0.5009E 02	0.3507E-00	0.2488E C3	0.2101E-00
0.9624E 02	0.6788E C0	0.4814E C3	0.4066E-00
0.1424E 03	0.1008E 01	0.7148E C3	0.6037E 00
0.1885E 03	0.1338E 01	0.9490E C3	0.8015E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.2347E 03	0.1889E-01	0.1340E C2	0.1000E 01
0.5009E 02	0.1719E-01	0.1219E C2	0.9097E 00
0.9624E 02	0.1821E-01	0.1292E C2	0.9640E 00
0.1424E 03	0.1858E-01	0.1318E C2	0.9837E 00
0.1885E 03	0.1878E-01	0.1332E C2	0.9938E 00

VARIATIONS CN PERI-APSIS DISTANCE--VENUS,RETURN
CLASS EX---C.0---A
BON= 0.5564E C1 RPERN(1)= 0.3934E C1 DVON= 0.1339E-00

RN	DELRPN	P	Q
0.2347E 03	0.1669E 01	0.1184E C4	0.100CE 01
0.1547E 02	0.1029E-00	0.7298E C2	0.6164E-01
0.2701E 02	0.1864E-00	0.1322E C3	0.1116E-00
0.3855E 02	0.2687E-00	0.1906E C3	0.1609E-00
0.5009E 02	0.3507E-00	0.2438E C3	0.2101E-00
0.6162E 02	0.4327E-00	0.3069E C3	0.2592E-00
0.7316E 02	0.5147E 00	0.3650E C3	0.3083E-00
0.8470E 02	0.5967E 00	0.4232E C3	0.3574E-00
0.9624E 02	0.6788E 00	0.4814E C3	0.4066E-00
0.1078E 03	0.7609E C0	0.5397E C3	0.4558E-00
0.1193E 03	0.8431E 00	0.5980E C3	0.505CE 00
0.1309E 03	0.9254E 00	0.6563E C3	0.5543E 00
0.1424E 03	0.1008E 01	0.7148E C3	0.6037E 00
0.1539E 03	0.1090E 01	0.7732E C3	0.6531E 00
0.1655E 03	0.1173E 01	0.8318E C3	0.7025E 00
0.1770E 03	0.1255E 01	0.89C4E C3	0.7520E 00
0.1885E 03	0.1338E 01	0.9490E C3	0.8015E 00
0.2001E 03	0.1421E 01	0.10C8E C4	0.8511E 00
0.2116E 03	0.1504E 01	0.1066E C4	0.9007E 00
0.2232E 03	0.1587E 01	0.1125E C4	0.9503E 00

```
M=2  FQ= 0.7030E 00      FM= 0.1422E 01      NOPT= 1
 N   RED. FACTOR      MULT.FACTOR    SUM/W            SUM/29.8
 1    0.7030E 00      0.1422E 01     0.1422E 01       0.4773E-01

M=3  FQ= 0.3515E-00      FM= 0.2845E 01      NOPT= 2
 N   RED. FACTOR      MULT.FACTOR    SUM/W            SUM/29.8
 2    0.5929E 00      0.1687E 01     0.2385E 01       0.8004E-01
 1    0.3515E-00      0.2845E 01     0.2845E 01       0.9546E-01

M=4  FQ= 0.2343E-00      FM= 0.4267E 01      NOPT= 3
 N   RED. FACTOR      MULT.FACTOR    SUM/W            SUM/29.8
 3    0.6165E 00      0.1622E 01     0.2809E 01       0.9427E-01
 2    0.4841E-00      0.2066E 01     0.2921E 01       0.9803E-01
 1    0.2343E-00      0.4267E 01     0.4267E 01       0.1432E-00

M=5  FQ= 0.1758E-00      FM= 0.5690E 01      NOPT= 3
 N   RED. FACTOR      MULT.FACTOR    SUM/W            SUM/29.8
 3    0.5601E 00      0.1785E 01     0.3092E 01       0.1038E-00
 2    0.4192E-00      0.2385E 01     0.3373E 01       0.1132E-00
 1    0.1758E-00      0.5690E 01     0.5690E 01       0.1909E-00

TIME FROM PERI-APSIS IN MINUTES

CLASS    EX---0,0---A       VENUS-OPT-RETURN
 1  CORRECTION STEPS
N       RANGE            TIME           DELTA-TIME
0    0.2347E 03       0.4289E 04      0.
1    0.4450E 02       0.7653E 03      0.3524E 04

TIME FROM PERI-APSIS IN MINUTES

CLASS    EX---0,0---A       VENUS-OPT-RETURN
 2  CORRECTION STEPS
N       RANGE            TIME           DELTA-TIME
0    0.2347E 03       0.4289E 04      0.
1    0.1007E 03       0.1796E 04      0.2492E 04
2    0.4449E 02       0.7650E 03      0.1031E 04

TIME FROM PERI-APSIS IN MINUTES

CLASS    EX---0,0---A       VENUS-OPT-RETURN
 3  CORRECTION STEPS
N       RANGE            TIME           DELTA-TIME
0    0.2347E 03       0.4289E 04      0.
1    0.1332E 03       0.2399E 04      0.1890E 04
2    0.7633E 02       0.1348E 04      0.1051E 04
3    0.4448E 02       0.7649E 03      0.5826E 03
```

COMPARISON CF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS EX---0.0---A VENUS, RETURN
BON= 0.2288E C1 AON= 0.1967E 01 ECCO= 0.1534E 01

TRANSVERSE ERROR

RN	DELRPN	P	Q
0.2347E 03	0.1472E 01	0.1044E C4	0.1000E 01
0.4778E C2	0.2776E-00	0.1969E C3	0.1886E-00
0.9451E 02	0.5629E 00	0.3993E C3	0.3824E-00
0.1412E 03	0.8584E 00	0.6088E C3	0.5832E 00
0.1880E 03	0.1162E 01	0.8241E 03	0.7894E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.2347E 03	0.1003E-01	0.7117E C1	0.1000E 01
0.4778E 02	0.9553E-02	0.6775E C1	0.9520E 00
0.9451E 02	0.9847E-02	0.6984E 01	0.9813E 00
0.1412E 03	0.9950E-02	0.7057E 01	0.9916E 00
0.1880E 03	0.1000E-01	0.7094E C1	0.9968E 00

VARIATIONS CN PERI-APSIS DISTANCE--VENUS,RETURN
CLASS EX---0.0---A
BON= 0.2288E 01 RPERN(2)= 0.1050E 01 DVON= 0.1534E-00

RN	DELRPN	P	Q
0.2347E 03	0.1472E 01	0.1044E C4	0.1000E 01
0.1273E 02	0.7159E-01	0.5077E C2	0.4863E-01
0.2441E 02	0.1395E-00	0.9895E C2	0.9479E-01
0.3610E 02	0.2082E-00	0.1476E C3	0.1414E-00
0.4778E 02	0.2776E-00	0.1969E C3	0.1886E-00
0.5946E 02	0.3479E-00	0.2467E C3	0.2363E-00
0.7114E 02	0.4189E-00	0.2971E C3	0.2846E-00
0.8283E 02	0.4906E-00	0.3479E C3	0.3333E-00
0.9451E 02	0.5629E 00	0.3993E 03	0.3824E-00
0.1062E 03	0.6360E C0	0.4510E C3	0.4320E-00
0.1179E 03	0.7096E 00	0.5032E C3	0.4820E-00
0.1296E 03	0.7837E 00	0.5558E C3	0.5324E 00
0.1412E 03	0.8584E 00	0.6088E 03	0.5832E 00
0.1529E 03	0.9336E 00	0.6622E C3	0.6343E 00
0.1646E 03	0.1009E 01	0.7158E C3	0.6857E 00
0.1763E 03	0.1085E 01	0.7698E 03	0.7374E 00
0.1880E 03	0.1162E 01	0.8241E C3	0.7894E 00
0.1996E 03	0.1239E 01	0.8787E C3	0.8417E 00
0.2113E 03	0.1316E 01	0.9335E C3	0.8942E 00
0.2230E 03	0.1394E 01	0.9886E 03	0.9470E 00

M=1 FQ= 0.3413E-01 FM= 0.2930E 02 NOPT= 7

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
7	0.6172E 00	0.1620E 01	0.4287E 01	0.1438E-00
6	0.5695E 00	0.1756E 01	0.4301E 01	0.1443E-00
5	0.5089E 00	0.1965E 01	0.4394E 01	0.1475E-00
4	0.4298E-00	0.2327E 01	0.4653E 01	0.1561E-00
3	0.3244E-00	0.3083E 01	0.5340E 01	0.1792E-00

M=2 FQ= 0.1365E-01 FM= 0.7325E 02 NOPT= 9

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
9	0.6206E 00	0.1611E 01	0.4834E 01	0.1622E-00
8	0.5846E 00	0.1710E 01	0.4838E 01	0.1623E-00
7	0.5415E 00	0.1847E 01	0.4886E 01	0.1640E-00
6	0.4889E-00	0.2046E 01	0.5011E 01	0.1681E-00
5	0.4237E-00	0.2360E 01	0.5278E 01	0.1771E-00

M=3 FQ= 0.6825E-02 FM= 0.1465E 03 NOPT=10

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
10	0.6073E 00	0.1647E 01	0.5207E 01	0.1747E-00
9	0.5746E 00	0.1740E 01	0.5221E 01	0.1752E-00
8	0.5361E 00	0.1865E 01	0.5276E 01	0.1770E-00
7	0.4904E-00	0.2039E 01	0.5395E 01	0.1810E-00
6	0.4355E-00	0.2296E 01	0.5624E 01	0.1887E-00

M=4 FQ= 0.4550E-02 FM= 0.2198E 03 NOPT=11

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
11	0.6125E 00	0.1633E 01	0.5415E 01	0.1817E-00
10	0.5832E 00	0.1715E 01	0.5422E 01	0.1820E-00
9	0.5493E 00	0.1821E 01	0.5462E 01	0.1833E-00
8	0.5096E 00	0.1962E 01	0.5550E 01	0.1862E-00
7	0.4628E-00	0.2161E 01	0.5716E 01	0.1918E-00

M=5 FQ= 0.3413E-02 FM= 0.2930E 03 NOPT=11

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
11	0.5967E 00	0.1676E 01	0.5559E 01	0.1865E-00
10	0.5666E 00	0.1765E 01	0.5581E 01	0.1873E-00
9	0.5320E 00	0.1880E 01	0.5639E 01	0.1892E-00
8	0.4916E-00	0.2034E 01	0.5753E 01	0.1931E-00
7	0.4442E-00	0.2251E 01	0.5956E 01	0.1999E-00

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---A VENUS-CLOSE-RETURN

7 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.4265E 04	0.
1	0.1048E 03	0.1851E 04	0.2414E 04
2	0.4715E 02	0.7935E 03	0.1057E 04
3	0.2153E 02	0.3369E 03	0.4566E 03
4	0.1015E 02	0.1442E 03	0.1927E 03
5	0.5091E 01	0.6476E 02	0.7946E 02
6	0.2845E 01	0.3193E 02	0.3283E 02
7	0.1847E 01	0.1756E 02	0.1437E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---A VENUS-CLOSE-RETURN

9 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.4265E 04	0.
1	0.1254E 03	0.2231E 04	0.2035E 04
2	0.6718E 02	0.1158E 04	0.1072E 04
3	0.3623E 02	0.5969E 03	0.5613E 03
4	0.1977E 02	0.3064E 03	0.2905E 03
5	0.1101E 02	0.1583E 03	0.1481E 03
6	0.6347E 01	0.8388E 02	0.7440E 02
7	0.3868E 01	0.4667E 02	0.3721E 02
8	0.2549E 01	0.2771E 02	0.1896E 02
9	0.1848E 01	0.1757E 02	0.1015E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---A VENUS-CLOSE-RETURN

11 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.4265E 04	0.
1	0.1405E 03	0.2511E 04	0.1754E 04
2	0.8424E 02	0.1471E 04	0.1040E 04
3	0.5069E 02	0.8576E 03	0.6136E 03
4	0.3067E 02	0.4977E 03	0.3599E 03
5	0.1872E 02	0.2884E 03	0.2093E 03
6	0.1160E 02	0.1680E 03	0.1204E 03
7	0.7343E 01	0.9937E 02	0.6861E 02
8	0.4805E 01	0.6048E 02	0.3888E 02
9	0.3291E 01	0.3832E 02	0.2217E 02
10	0.2387E 01	0.2539E 02	0.1292E 02
11	0.1848E 01	0.1757E 02	0.7826E 01

COMPARISON CF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS EX---C.C---C VENUS, RETURN
BON= 0.4674E 01 AON= 0.1652E 01 ECCC= 0.3000E 01

TRANSVERSE ERROR

RN	DELRPN	P	Q
0.2347E 03	0.1532E 01	0.1086E C4	0.1000E 01
0.4958E 02	0.3188E-00	0.2261E C3	0.2082E-00
0.9586E 02	0.6203E 00	0.4399E 03	0.4050E-00
0.1421E 03	0.9229E 00	0.6545E C3	0.6025E 00
0.1884E 03	0.1227E 01	0.8700E C3	0.8009E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.2347E 03	0.1461E-01	0.1037E C2	0.1000E 01
0.4958E 02	0.1349E-01	0.9566E C1	0.9229E 00
0.9586E 02	0.1417E-01	0.1005E C2	0.9695E 00
0.1421E 03	0.1441E-01	0.1022E C2	0.9862E 00
0.1884E 03	0.1454E-01	0.1031E C2	0.9948E 00

VARIATIONS CN PERI-APSIS DISTANCE--VENUS,RETURN
CLASS EX---C.C---C
BCN= 0.4674E C1 RPERN(1)= 0.3305E 01 DVON= 0.1461E

RN	DELRPN	P	Q
0.2347E 03	0.1532E 01	0.1086E C4	0.1000E 01
0.1487E 02	0.9181E-01	0.6511E C2	0.5994E-01
0.2644E 02	0.1681E-00	0.1192E 03	0.1097E-00
0.3801E 02	0.2435E-00	0.1727E C3	0.1590E-00
0.4958E 02	0.3188E-00	0.2261E C3	0.2082E-00
0.6115E 02	0.3941E-00	0.2795E C3	0.2573E-00
0.7272E 02	0.4694E-00	0.3329E C3	0.3065E-00
0.8429E 02	0.5448E 00	0.3864E C3	0.3557E-00
0.9586E 02	0.6203E 00	0.4399E C3	0.4050E-00
0.1074E 03	0.6958E 00	0.4935E C3	0.4543E-00
0.1190E 03	0.7714E 00	0.5471E C3	0.5036E 00
0.1306E 03	0.8471E 00	0.6008E C3	0.5531E 00
0.1421E 03	0.9229E 00	0.6545E C3	0.6025E 00
0.1537E 03	0.9988E 00	0.7083E C3	0.6520E 00
0.1653E 03	0.1075E 01	0.7622E C3	0.7016E 00
0.1768E 03	0.1151E 01	0.8161E C3	0.7512E 00
0.1884E 03	0.1227E 01	0.8700E C3	0.8009E 00
0.2000E 03	0.1303E 01	0.9240E C3	0.8506E 00
0.2116E 03	0.1379E 01	0.9781E C3	0.9004E 00
0.2231E 03	0.1455E 01	0.1032E C4	0.9502E 00

M=2 FQ= 0.6019E 00 FM= 0.1661E 01 NOPT= 1

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
1	0.6019E 00	0.1661E 01	0.1661E 01	0.5575E-01

M=3 FQ= 0.3010E-00 FM= 0.3323E 01 NOPT= 2

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
2	0.5486E 00	0.1823E 01	0.2578E 01	0.8651E-01
1	0.3010E-00	0.3323E 01	0.3323E 01	0.1115E-00

M=4 FQ= 0.2006E-00 FM= 0.4984E 01 NOPT= 3

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
3	0.5854E 00	0.1708E 01	0.2959E 01	0.9928E-01
2	0.4479E-00	0.2233E 01	0.3157E 01	0.1059E-00
1	0.2006E-00	0.4984E 01	0.4984E 01	0.1673E-00

M=5 FQ= 0.1505E-00 FM= 0.6646E 01 NOPT= 4

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
4	0.6228E 00	0.1606E 01	0.3211E 01	0.1078E-00
3	0.5319E 00	0.1880E 01	0.3256E 01	0.1093E-00
2	0.3879E-00	0.2578E 01	0.3646E 01	0.1223E-00
1	0.1505E-00	0.6646E 01	0.6646E 01	0.2230E-00

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---C VENUS-OPT-RETURN
1 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.3944E 04	0.
1	0.3813E 02	0.6016E 03	0.3343E 04

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---C VENUS-OPT-RETURN
3 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.3944E 04	0.
1	0.1264E 03	0.2094E 04	0.1851E 04
2	0.6877E 02	0.1116E 04	0.9776E 03
3	0.3813E 02	0.6015E 03	0.5143E 03

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---C VENUS-OPT-RETURN
4 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.3944E 04	0.
1	0.1474E 03	0.2452E 04	0.1492E 04
2	0.9306E 02	0.1527E 04	0.9251E 03
3	0.5920E 02	0.9546E 03	0.5723E 03
4	0.3812E 02	0.6014E 03	0.3532E 03

CCMPARISON CF LCNGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS EX---0.0---C VENUS, RETURN
BCN= 0.2139E 01 AON= 0.1652E 01 ECCO= 0.1636E 01
TRANSVERSE ERROR

RN	DELRPN	P	Q
0.2347E 03	0.1386E 01	0.9832E C3	0.1000E 01
0.4778E 02	0.2645E-00	0.1876E C3	0.1908E-00
0.9451E 02	0.5343E 00	0.3790E C3	0.3854E-00
0.1412E 03	0.8124E 00	0.5762E C3	0.5860E 00
0.1880E 03	0.1C97E 01	0.7779E C3	0.7912E 00

LCNGITUDINAL ERROR

RN	DELRPN	P	Q
0.2347E C3	0.8633E-C2	0.6123E C1	0.1000E 01
0.4778E 02	0.8259E-02	0.5857E C1	0.9566E 00
0.9451E 02	0.8488E-02	0.6020E 01	0.9832E 00
0.1412E 03	0.8568E-02	0.6077E C1	0.9925E 00
0.1880E 03	0.8609E-C2	0.61C6E C1	0.9972E 00

VARIATIONS CN PERI-APSIS DISTANCE--VENUS,RETURN
CLASS EX---0.0---C
BON= 0.2139E C1 RPERN(2)= 0.105CE 01 DVON= 0.1616E-00

RN	DELRPN	P	Q
0.2347E 03	0.1386E C1	0.9832E C3	0.1000E 01
0.1273E 02	0.6847E-01	0.4856E C2	0.4939E-01
0.2441E 02	0.1332E-00	0.9448E C2	0.9609E-01
0.3610E 02	0.1985E-00	0.1408E C3	0.1432E-00
0.4778E 02	0.2645E-00	0.1876E C3	0.1908E-00
0.5946E 02	0.3311E-00	0.2348E C3	0.2388E-00
0.7114E 02	0.3983E-00	0.2824E C3	0.2873E-00
0.8283E 02	0.4660E-00	0.33C5E C3	0.3362E-00
0.9451E 02	0.5343E 00	0.3790E C3	0.3854E-00
0.1062E 03	0.6C32E 00	0.4278E C3	0.4351E-00
0.1179E 03	0.6725E 00	0.4769E C3	0.4851E-00
0.1296E 03	0.7422E 00	C.5264E C3	0.5354E 00
0.1412E 03	0.8124E 00	0.5762E C3	0.5860E 00
0.1529E 03	0.8829E 00	0.6262E C3	0.6369E 00
0.1646E 03	0.9539E 00	0.6765E C3	0.6881E 00
0.1763E 03	0.1C25E 01	C.7271E C3	0.7395E 00
0.1880E 03	0.1097E 01	0.7779E C3	0.7912E 00
0.1996E 03	0.1169E 01	0.8289E C3	0.8431E 00
0.2113E 03	0.1241E 01	C.88C2E C3	0.8952E 00
0.2230E 03	0.1314E 01	0.9316E C3	C.9475E 00

M=1 FQ= 0.3624E-01 FM= 0.2760E C2 NCPT= 7

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
7	0.6225E 00	0.1606E 01	0.4250E 01	0.1426E-00
6	0.5752E 0C	0.1738E 01	0.4258E 01	C.1429E-00
5	0.515CE 00	0.1942E 01	0.4342E 01	0.1457E-00
4	0.4363E-00	0.2292E 01	0.4584E 01	0.1538E-00
3	0.3309E-00	0.3022E 01	0.5234E 01	0.1756E-00

M=2 FQ= 0.1449E-01 FM= 0.6899E C2 NOPT= 8

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
8	0.589CE 00	0.1698E 01	0.4802E 01	0.1611E-00
7	0.5462E 00	0.1831E 01	0.4844E 01	0.1626E-00
6	0.4938E-00	C.2025E 01	0.4961E 01	0.1665E-C0
5	0.4288E-0C	0.2332E 01	0.5215E 01	0.1750E-00
4	0.347CE-00	0.2882E 01	0.5764E 01	0.1934E-00

M=3 FQ= 0.7247E-02 FM= 0.1380E C3 NOPT=10

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
10	0.611CE 00	0.1637E 01	0.5176E 01	0.1737E-00
9	0.5784E 00	0.1729E 01	0.5187E 01	0.1740E-00
8	0.5402E 00	C.1851E 01	0.5236E 01	0.1757E-00
7	0.4947E-0C	0.2022E 01	0.5349E 01	0.1795E-00
6	0.4395E-00	0.2273E 01	0.5568E 01	0.1869E-00

M=4 FQ= 0.4831E-02 FM= 0.2070E C3 NOPT=11

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
11	0.6158E 00	0.1624E 01	0.5386E 01	0.1807E-00
10	0.5867E 0C	0.1704E 01	0.5390E 01	0.1809E-00
9	0.5529E 00	0.1809E 01	0.5426E 01	0.1821E-00
8	0.5135E 00	C.1948E 01	0.5509E 01	0.1848E-C0
7	0.4668E-00	0.2142E 01	0.5668E 01	0.1902E-00

M=5 FQ= 0.3624E-02 FM= 0.2760E C3 NOPT=11

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
11	0.5999E 00	0.1667E 01	0.5528E 01	0.1855E-00
1C	0.5701E 0C	0.1754E 01	0.5547E 01	C.1862E-00
9	0.5355E 00	C.1867E 01	0.5602E 01	0.1880E-00
8	0.4953E-00	0.2019E 01	0.5710E 01	0.1916E-00
7	0.448CE-0C	C.2232E 01	0.5905E 01	0.1982E-00

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---C VENUS-CLOSE-RETURN
7 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.3928E 04	0.
1	0.1057E 03	0.1726E 04	0.2202E 04
2	0.4794E 02	0.7513E 03	0.9749E 03
3	0.2206E 02	0.3246E 03	0.4266E 03
4	0.1046E 02	0.1415E 03	0.1832E 03
5	0.5267E 01	0.6445E 02	0.7704E 02
6	0.2939E 01	0.3202E 02	0.3243E 02
7	0.1896E 01	0.1766E 02	0.1436E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---C VENUS-CLOSE-RETURN
9 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.3928E 04	0.
1	0.1262E 03	0.2074E 04	0.1854E 04
2	0.6805E 02	0.1089E 04	0.9852E 03
3	0.3693E 02	0.5681E 03	0.5205E 03
4	0.2026E 02	0.2957E 03	0.2724E 03
5	0.1134E 02	0.1549E 03	0.1408E 03
6	0.6560E 01	0.8310E 02	0.7183E 02
7	0.4000E 01	0.4662E 02	0.3648E 02
8	0.2630E 01	0.2780E 02	0.1882E 02
9	0.1896E 01	0.1766E 02	0.1015E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---C VENUS-CLOSE-RETURN
11 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.3928E 04	0.
1	0.1412E 03	0.2330E 04	0.1598E 04
2	0.8514E 02	0.1377E 04	0.9530E 03
3	0.5149E 02	0.8106E 03	0.5665E 03
4	0.3131E 02	0.4755E 03	0.3351E 03
5	0.1920E 02	0.2787E 03	0.1968E 03
6	0.1194E 02	0.1642E 03	0.1145E 03
7	0.7583E 01	0.9814E 02	0.6606E 02
8	0.4969E 01	0.6022E 02	0.3792E 02
9	0.3401E 01	0.3835E 02	0.2187E 02
10	0.2460E 01	0.2549E 02	0.1286E 02
11	0.1896E 01	0.1766E 02	0.7830E 01

COMPARISON OF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS EX---0.0---D VENUS, RETURN
BON= 0.4247E 01 AON= 0.1502E 01 ECCO= 0.3000E 01

TRANSVERSE ERROR

RN	DELRPN	P	Q
0.2347E 03	0.1461E 01	0.1036E 04	0.1000E 01
0.4934E 02	0.3027E-00	0.2147E 03	0.2072E-00
0.9568E 02	0.5905E 00	0.4188E 03	0.4042E-00
0.1420E 03	0.8794E 00	0.6237E 03	0.6020E 00
0.1884E 03	0.1170E 01	0.8295E 03	0.8006E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.2347E 03	0.1269E-01	0.8998E 01	0.1000E 01
0.4934E 02	0.1179E-01	0.8363E 01	0.9293E 00
0.9568E 02	0.1234E-01	0.8749E 01	0.9722E 00
0.1420E 03	0.1253E-01	0.8886E 01	0.9875E 00
0.1884E 03	0.1263E-01	0.8956E 01	0.9953E 00

VARIATIONS ON PERI-APSIS DISTANCE--VENUS,RETURN
CLASS EX---0.0---D
BON= 0.4247E 01 RPERN(1)= 0.3003E 01 DVON= 0.1533E-00

RN	DELRPN	P	Q
0.2347E 03	0.1461E 01	0.1036E 04	0.1000E 01
0.1459E 02	0.8633E-01	0.6123E 02	0.5909E-01
0.2617E 02	0.1589E-00	0.1127E 03	0.1088E-00
0.3776E 02	0.2309E-00	0.1637E 03	0.1580E-00
0.4934E 02	0.3027E-00	0.2147E 03	0.2072E-00
0.6093E 02	0.3746E-00	0.2656E 03	0.2564E-00
0.7251E 02	0.4464E-00	0.3166E 03	0.3056E-00
0.8409E 02	0.5184E 00	0.3677E 03	0.3548E-00
0.9568E 02	0.5905E 00	0.4188E 03	0.4042E-00
0.1073E 03	0.6626E 00	0.4699E 03	0.4535E-00
0.1188E 03	0.7348E 00	0.5211E 03	0.5030E 00
0.1304E 03	0.8071E 00	0.5724E 03	0.5524E 00
0.1420E 03	0.8794E 00	0.6237E 03	0.6020E 00
0.1536E 03	0.9519E 00	0.6751E 03	0.6516E 00
0.1652E 03	0.1024E 01	0.7265E 03	0.7012E 00
0.1768E 03	0.1097E 01	0.7780E 03	0.7509E 00
0.1884E 03	0.1170E 01	0.8295E 03	0.8006E 00
0.1999E 03	0.1242E 01	0.8811E 03	0.8504E 00
0.2115E 03	0.1315E 01	0.9327E 03	0.9002E 00
0.2231E 03	0.1388E 01	0.9844E 03	0.9501E 00

M=2 FQ= 0.5484E 00 FM= 0.1823E 01 NCPT= 1

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
1	0.5484E 00	0.1823E 01	0.1823E 01	0.6119E-01

M=3 FQ= 0.2742E-00 FM= 0.3647E 01 NCPT= 3

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
3	0.6497E 00	0.1539E 01	0.2666E 01	0.8946E-01
2	0.5237E 00	0.1910E 01	0.2701E 01	0.9063E-01
1	0.2742E-00	0.3647E 01	0.3647E 01	0.1224E-00

M=4 FQ= 0.1828E-00 FM= 0.5470E 01 NCPT= 3

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
3	0.5675E 00	0.1762E 01	0.3052E 01	0.1024E-00
2	0.4276E-00	0.2339E 01	0.3308E 01	0.1110E-00
1	0.1828E-00	0.5470E 01	0.5470E 01	0.1836E-00

M=5 FQ= 0.1371E-00 FM= 0.7294E 01 NCPT= 4

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
4	0.6085E 00	0.1643E 01	0.3287E 01	0.1103E-00
3	0.5156E 00	0.1939E 01	0.3359E 01	0.1127E-00
2	0.3703E-00	0.2701E 01	0.3819E 01	0.1282E-00
1	0.1371E-00	0.7294E 01	0.7294E 01	0.2448E-00

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---D VENUS-OPT-RETURN

1 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.3768E 04	0.
1	0.3477E 02	0.5232E 03	0.3244E 04

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---D VENUS-OPT-RETURN

3 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.3768E 04	0.
1	0.1225E 03	0.1938E 04	0.1830E 04
2	0.6460E 02	0.1001E 04	0.9370E 03
3	0.3476E 02	0.5230E 03	0.4777E 03

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---D VENUS-OPT-RETURN

4 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.3768E 04	0.
1	0.1440E 03	0.2288E 04	0.1480E 04
2	0.8879E 02	0.1392E 04	0.8964E 03
3	0.5521E 02	0.8497E 03	0.5418E 03
4	0.3477E 02	0.5232E 03	0.3266E 03

COMPARISON OF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS EX---0.0---D VENUS, RETURN
BON= 0.2063E 01 AON= 0.1502E 01 ECCC= 0.1699E 01

TRANSVERSE ERROR

RN	DELRPN	P	Q
0.2347E 03	0.1340E 01	0.9500E 03	0.1000E 01
0.4778E 02	0.2570E-00	0.1823E 03	0.1919E-00
0.9451E 02	0.5184E 00	0.3676E 03	0.3870E-00
0.1412E 03	0.7869E 00	0.5581E 03	0.5874E 00
0.1880E 03	0.1061E 01	0.7525E 03	0.7921E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.2347E 03	0.7924E-02	0.5620E 01	0.1000E 01
0.4778E 02	0.7598E-02	0.5389E 01	0.9589E 00
0.9451E 02	0.7798E-02	0.5531E 01	0.9841E 00
0.1412E 03	0.7868E-02	0.5580E 01	0.9929E 00
0.1880E 03	0.7903E-02	0.5605E 01	0.9973E 00

VARIATIONS ON PERI-APSIS DISTANCE--VENUS,RETURN
CLASS EX---C.C---D
BON= 0.2063E 01 RPERN(2)= 0.1050E 01 DVON= 0.1666E-00

RN	DELRPN	P	Q
0.2347E 03	0.1340E 01	0.9500E 03	0.1000E 01
0.1273E 02	0.6669E-01	0.4730E 02	0.4979E-01
0.2441E 02	0.1296E-00	0.9193E 02	0.9676E-01
0.3610E 02	0.1930E-00	0.1369E 03	0.1441E-00
0.4778E 02	0.2570E-00	0.1823E 03	0.1919E-00
0.5946E 02	0.3216E-00	0.2281E 03	0.2401E-00
0.7114E 02	0.3867E-00	0.2742E 03	0.2887E-00
0.8283E 02	0.4523E-00	0.3208E 03	0.3376E-00
0.9451E 02	0.5184E 00	0.3676E 03	0.3870E-00
0.1062E 03	0.5849E 00	0.4148E 03	0.4366E-00
0.1179E 03	0.6518E 00	0.4623E 03	0.4866E-00
0.1296E 03	0.7192E 00	0.5100E 03	0.5369E 00
0.1412E 03	0.7869E 00	0.5581E 03	0.5874E 00
0.1529E 03	0.8549E 00	0.6063E 03	0.6382E 00
0.1646E 03	0.9233E 00	0.6548E 03	0.6893E 00
0.1763E 03	0.9920E 00	0.7036E 03	0.7406E 00
0.1880E 03	0.1061E 01	0.7525E 03	0.7921E 00
0.1996E 03	0.1130E 01	0.8016E 03	0.8438E 00
0.2113E 03	0.1200E 01	0.8509E 03	0.8957E 00
0.2230E 03	0.1270E 01	0.9004E 03	0.9477E 00

M=1 FQ= 0.3750E-01 FM= 0.2667E 02 NOPT= 7

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
7	0.6256E 00	0.1598E 01	0.4229E 01	0.1419E-00
6	0.5786E 00	0.1728E 01	0.4234E 01	0.1421E-00
5	0.5186E 00	0.1928E 01	0.4312E 01	0.1447E-00
4	0.4401E-00	0.2272E 01	0.4545E 01	0.1525E-00
3	0.3347E-00	0.2988E 01	0.5175E 01	0.1736E-00

M=2 FQ= 0.1500E-01 FM= 0.6666E 02 NOPT= 8

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
8	0.5916E 00	0.1690E 01	0.4781E 01	0.1604E-00
7	0.5488E 00	0.1822E 01	0.4821E 01	0.1618E-00
6	0.4966E-00	0.2014E 01	0.4932E 01	0.1655E-00
5	0.4317E-00	0.2316E 01	0.5179E 01	0.1738E-00
4	0.3500E-00	0.2857E 01	0.5715E 01	0.1918E-00

M=3 FQ= 0.7500E-02 FM= 0.1333E 03 NOPT=10

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
10	0.6131E 00	0.1631E 01	0.5158E 01	0.1731E-00
9	0.5806E 00	0.1722E 01	0.5167E 01	0.1734E-00
8	0.5425E 00	0.1843E 01	0.5214E 01	0.1750E-00
7	0.4971E-00	0.2012E 01	0.5322E 01	0.1786E-00
6	0.4424E-00	0.2260E 01	0.5536E 01	0.1858E-00

M=4 FQ= 0.5000E-02 FM= 0.2000E 03 NOPT=11

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
11	0.6178E 00	0.1619E 01	0.5369E 01	0.1802E-00
10	0.5887E 00	0.1699E 01	0.5372E 01	0.1803E-00
9	0.5551E 00	0.1802E 01	0.5405E 01	0.1814E-00
8	0.5157E 00	0.1939E 01	0.5485E 01	0.1841E-00
7	0.4691E-00	0.2132E 01	0.5640E 01	0.1893E-00

M=5 FQ= 0.3750E-02 FM= 0.2667E 03 NOPT=11

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
11	0.6018E 00	0.1662E 01	0.5511E 01	0.1849E-00
10	0.5720E 00	0.1748E 01	0.5528E 01	0.1855E-00
9	0.5376E 00	0.1860E 01	0.5580E 01	0.1873E-00
8	0.4975E-00	0.2010E 01	0.5686E 01	0.1908E-00
7	0.4502E-00	0.2221E 01	0.5876E 01	0.1972E-00

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---D VENUS-CLOSE-RETURN

7. CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.3754E 04	0.
1	0.1062E 03	0.1661E 04	0.2093E 04
2	0.4841E 02	0.7289E 03	0.9323E 03
3	0.2237E 02	0.3180E 03	0.4110E 03
4	0.1065E 02	0.1399E 03	0.1780E 03
5	0.5371E 01	0.6423E 02	0.7569E 02
6	0.2995E 01	0.3206E 02	0.3218E 02
7	0.1926E 01	0.1771E 02	0.1435E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---D VENUS-CLOSE-RETURN

9 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.3754E 04	0.
1	0.1267E 03	0.1993E 04	0.1761E 04
2	0.6858E 02	0.1052E 04	0.9403E 03
3	0.3735E 02	0.5531E 03	0.4994E 03
4	0.2057E 02	0.2901E 03	0.2630E 03
5	0.1154E 02	0.1531E 03	0.1369E 03
6	0.6691E 01	0.8269E 02	0.7045E 02
7	0.4082E 01	0.4661E 02	0.3608E 02
8	0.2680E 01	0.2787E 02	0.1874E 02
9	0.1926E 01	0.1772E 02	0.1015E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---D VENUS-CLOSE-RETURN

11 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.3754E 04	0.
1	0.1417E 03	0.2237E 04	0.1517E 04
2	0.8567E 02	0.1328E 04	0.9085E 03
3	0.5197E 02	0.7859E 03	0.5423E 03
4	0.3170E 02	0.4637E 03	0.3222E 03
5	0.1949E 02	0.2735E 03	0.1902E 03
6	0.1215E 02	0.1622E 03	0.1114E 03
7	0.7729E 01	0.9747E 02	0.6469E 02
8	0.5070E 01	0.6007E 02	0.3740E 02
9	0.3469E 01	0.3837E 02	0.2171E 02
10	0.2506E 01	0.2554E 02	0.1282E 02
11	0.1926E 01	0.1771E 02	0.7831E 01

COMPARISON OF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS BI--1/2.1--H MARS, RETURN
BON= 0.2169E 02 AON= 0.7668E 01 ECCO= 0.3000E 01

TRANSVERSE ERROR

RN	DELRPN	P	Q
0.2347E 03	0.3263E 01	0.2315E 04	0.1000E 01
0.5921E 02	0.7761E 00	0.5504E 03	0.2378E-00
0.1031E 03	0.1405E 01	0.9963E 03	0.4304E-00
0.1470E 03	0.2025E 01	0.1437E 04	0.6207E 00
0.1908E 03	0.2645E 01	0.1876E 04	0.8103E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.2347E 03	0.1339E-00	0.9500E 02	0.1000E 01
0.5921E 02	0.9753E-01	0.6917E 02	0.7282E 00
0.1031E 03	0.1174E-00	0.8326E 02	0.8765E 00
0.1470E 03	0.1260E-00	0.8938E 02	0.9409E 00
0.1908E 03	0.1309E-00	0.9281E 02	0.9769E 00

VARIATIONS ON PERI-APSIS DISTANCE--MARS,RETURN
CLASS BI--1/2.1--H
BON= 0.2169E 02 RPERN(1)= 0.1534E 02 DVON= 0.6782E-01

RN	DELRPN	P	Q
0.2347E 03	0.3263E 01	0.2315E 04	0.1000E 01
0.2630E 02	0.2745E-00	0.1947E 03	0.8410E-01
0.3727E 02	0.4498E-00	0.3190E 03	0.1378E-00
0.4824E 02	0.6151E 00	0.4362E 03	0.1885E-00
0.5921E 02	0.7761E 00	0.5504E 03	0.2378E-00
0.7018E 02	0.9349E 00	0.6630E 03	0.2865E-00
0.8114E 02	0.1092E 01	0.7746E 03	0.3347E-00
0.9211E 02	0.1249E 01	0.8857E 03	0.3827E-00
0.1031E 03	0.1405E 01	0.9963E 03	0.4304E-00
0.1140E 03	0.1560E 01	0.1107E 04	0.4781E-00
0.1250E 03	0.1716E 01	0.1217E 04	0.5257E 00
0.1360E 03	0.1871E 01	0.1327E 04	0.5732E 00
0.1470E 03	0.2025E 01	0.1437E 04	0.6207E 00
0.1579E 03	0.2180E 01	0.1546E 04	0.6681E 00
0.1689E 03	0.2335E 01	0.1656E 04	0.7155E 00
0.1799E 03	0.2490E 01	0.1766E 04	0.7629E 00
0.1908E 03	0.2645E 01	0.1876E 04	0.8103E 00
0.2018E 03	0.2799E 01	0.1985E 04	0.8577E 00
0.2128E 03	0.2954E 01	0.2095E 04	0.9052E 00
0.2237E 03	0.3109E 01	0.2205E 04	0.9526E 00

M=4 FQ= 0.5857E 00 FM= 0.1707E 01 NCPT= 1

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
1	0.5857E 00	0.1707E 01	0.1707E 01	0.5729E-01

M=5 FQ= 0.4393E-00 FM= 0.2276E 01 NCPT= 2

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
2	0.6628E 00	0.1509E 01	0.2134E 01	0.7160E-01
1	0.4393E-00	0.2276E 01	0.2276E 01	[illegible]

TIME FROM PERI-APSIS IN MINUTES

CLASS BI--1/2,1--H MARS-OPT-RETURN
1 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.8095E 04	0.
1	0.1117E 03	0.3687E 04	0.4407E 04

TIME FROM PERI-APSIS IN MINUTES

CLASS BI--1/2,1--H MARS-OPT-RETURN
2 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.8095E 04	0.
1	0.1607E 03	0.5434E 04	0.2661E 04
2	0.1117E 03	0.3687E 04	0.1746E 04

COMPARISON CF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS BI--1/2.1--H MARS, RETURN
BCN= 0.4148E 01 AON= 0.7668E 01 ECCO= 0.1137E 01
TRANSVERSE ERROR

RN	DELRPN	P	Q
0.2347E 03	0.2077E 01	0.1473E C4	0.1000E 01
0.4778E 02	0.3542E-00	0.2512E C3	0.1706E-00
0.9451E 02	0.7397E 00	0.5246E C3	0.3562E-00
0.1412E C3	0.1158E 01	0.8211E C3	0.5575E 00
0.1880E 03	0.1605E 01	0.1138E C4	0.7727E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.2347E 03	0.2625E-01	0.1861E C2	0.1000E 01
0.4778E 02	0.2313E-01	0.1641E C2	0.8814E 00
0.9451E 02	0.2495E-01	0.1769E C2	0.9506E 00
0.1412E 03	0.2565E-01	0.1819E C2	0.9772E 00
0.1880E 03	0.2602E-01	0.1845E C2	0.9913E 00

VARIATIONS CN PERI-APSIS DISTANCE--MARS,RETURN
CLASS BI--1/2.1--H
BCN= 0.4148E 01 RPERN(2)= 0.105CE 01 DVON= C.1197E-00

RN	DELRPN	P	Q
0.2347E 03	0.2C77E 01	0.1473E C4	0.100CE 01
0.1273E 02	0.8835E-01	0.6266E C2	0.4254E-01
0.2441E 02	0.1748E-00	0.1239E C3	0.8415E-01
0.3610E 02	0.2633E-00	0.1868E C3	0.1268E-00
0.4778E 02	0.3542E-00	0.2512E C3	0.1706E-00
0.5946E 02	0.4473E-00	0.3172E C3	0.2154E-00
0.7114E 02	0.5426E 00	0.3848E C3	0.2613E-00
0.8283E 02	0.6401E 00	0.4540E C3	0.3082E-00
0.9451E 02	0.7397E 00	0.5246E C3	0.3562E-00
0.1062E 03	0.8413E 00	0.5967E C3	0.4051E-00
0.1179E 03	0.9449E 00	0.67C1E C3	0.455CE-00
0.1296E 03	0.1050E 01	0.7450E C3	0.5058E 00
0.1412E 03	0.1158E 01	0.8211E C3	0.5575E 00
0.1529E 03	0.1267E 01	0.8985E C3	0.6101E 00
0.1646E 03	0.1378E 01	0.9772E C3	0.6635E 00
0.1763E 03	0.1490E 01	0.1057E 04	0.7177E 00
0.1880E 03	0.1605E 01	0.1138E C4	0.7727E 00
0.1996E 03	0.1720E 01	0.1220E C4	0.8284E 00
0.2113E 03	0.1838E 01	0.13C3E C4	0.8849E 00
0.2230E 03	0.1956E 01	0.1388E C4	0.9421E 00

M=1 FQ= 0.2419E-01 FM= 0.4134E 02 NOPT= 7

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
7	0.5876E 00	0.1702E 01	0.4503E 01	0.1511E-00
6	0.5378E 00	0.1859E 01	0.4555E 01	0.1528E-00
5	0.4750E-00	0.2105E 01	0.4707E 01	0.1580E-00
4	0.3944E-00	0.2536E 01	0.5071E 01	0.1702E-00
3	0.2892E-00	0.3458E 01	0.5989E 01	0.2010E-00

M=2 FQ= 0.9676E-02 FM= 0.1033E 03 NOPT= 9

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
9	0.5973E 00	0.1674E 01	0.5023E 01	0.1685E-00
8	0.5600E 00	0.1786E 01	0.5050E 01	0.1695E-00
7	0.5155E 00	0.1940E 01	0.5132E 01	0.1722E-00
6	0.4616E-00	0.2166E 01	0.5306E 01	0.1781E-00
5	0.3955E-00	0.2528E 01	0.5654E 01	0.1897E-00

M=3 FQ= 0.4838E-02 FM= 0.2067E 03 NOPT=11

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
11	0.6159E 00	0.1624E 01	0.5385E 01	0.1807E-00
10	0.5868E 00	0.1704E 01	0.5389E 01	0.1808E-00
9	0.5530E 00	0.1808E 01	0.5425E 01	0.1820E-00
8	0.5136E 00	0.1947E 01	0.5508E 01	0.1848E-00
7	0.4669E-00	0.2142E 01	0.5666E 01	0.1901E-00

M=4 FQ= 0.3225E-02 FM= 0.3100E 03 NOPT=11

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
11	0.5936E 00	0.1685E 01	0.5587E 01	0.1875E-00
10	0.5635E 00	0.1775E 01	0.5612E 01	0.1883E-00
9	0.5287E 00	0.1892E 01	0.5675E 01	0.1904E-00
8	0.4882E-00	0.2048E 01	0.5794E 01	0.1944E-00
7	0.4406E-00	0.2269E 01	0.6004E 01	0.2015E-00

M=5 FQ= 0.2419E-02 FM= 0.4134E 03 NOPT=12

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
12	0.6053E 00	0.1652E 01	0.5723E 01	0.1920E-00
11	0.5783E 00	0.1729E 01	0.5735E 01	0.1925E-00
10	0.5475E 00	0.1827E 01	0.5776E 01	0.1938E-00
9	0.5120E 00	0.1953E 01	0.5859E 01	0.1966E-00
8	0.4709E-00	0.2123E 01	0.6006E 01	0.2015E-00

TIME FROM PERI-APSIS IN MINUTES

CLASS BI--1/2,1--H MARS-CLOSE-RETURN
8 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.7853E 04	0.
1	0.1111E 03	0.3458E 04	0.4395E 04
2	0.5286E 02	0.1477E 04	0.1981E 04
3	0.2545E 02	0.6142E 03	0.8629E 03
4	0.1254E 02	0.2546E 03	0.3597E 03
5	0.6460E 01	0.1101E 03	0.1445E 03
6	0.3598E 01	0.5227E 02	0.5785E 02
7	0.2250E 01	0.2787E 02	0.2440E 02
8	0.1615E 01	0.1646E 02	0.1141E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS BI--1/2,1--H MARS-CLOSE-RETURN
10 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.7853E 04	0.
1	0.1290E 03	0.4084E 04	0.3768F 04
2	0.7109E 02	0.2084E 04	0.2000E 04
3	0.3940E 02	0.1043E 04	0.1041E 04
4	0.2204E 02	0.5148E 03	0.5280E 03
5	0.1254E 02	0.2547E 03	0.2601E 03
6	0.7343E 01	0.1295E 03	0.1252E 03
7	0.4496E 01	0.6952E 02	0.5999E 02
8	0.2936E 01	0.4011E 02	0.2941E 02
9	0.2083E 01	0.2492E 02	0.1519E 02
10	0.1615E 01	0.1647E 02	0.8452E 01

TIME FROM PERI-APSIS IN MINUTES

CLASS BI--1/2,1--H MARS-CLOSE-RETURN
12 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.7853E 04	0.
1	0.1425E 03	0.4560E 04	0.3293E 04
2	0.8666E 02	0.2614E 04	0.1946E 04
3	0.5287E 02	0.1477E 04	0.1136E 04
4	0.3242E 02	0.8248E 03	0.6526E 03
5	0.2004E 02	0.4574E 03	0.3674E 03
6	0.1254E 02	0.2547E 03	0.2027E 03
7	0.8006E 01	0.1445E 03	0.1102E 03
8	0.5260E 01	0.8488E 02	0.5960E 02
9	0.3599E 01	0.5229E 02	0.3259E 02
10	0.2593E 01	0.3395E 02	0.1834E 02
11	0.1984E 01	0.2316E 02	0.1079E 02
12	0.1615E 01	0.1646E 02	0.6699E 01

```
COMPARISON OF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS    IN---C.0---A          MARS, RETURN
BON= 0.2153E 01      AON= 0.7613E 00      ECCO= 0.3000E 01
```

TRANSVERSE ERROR

RN	DELRPN	P	Q
0.2347E 03	0.1045E 01	0.7409E 03	0.1000E 01
0.4816E 02	0.2112E-00	0.1498E 03	0.2022E-00
0.9479E 02	0.4178E-00	0.2963E 03	0.3999E-00
0.1414E 03	0.6258E 00	0.4438E 03	0.5990E 00
0.1881E 03	0.8348E 00	0.5921E 03	0.7991E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.2347E 03	0.4634E-02	0.3286E 01	0.1000E 01
0.4816E 02	0.4461E-02	0.3164E 01	0.9627E 00
0.9479E 02	0.4567E-02	0.3239E 01	0.9857E 00
0.1414E 03	0.4604E-02	0.3265E 01	0.9936E 00
0.1881E 03	0.4622E-02	0.3278E 01	0.9976E 00

```
VARIATIONS ON PERI-APSIS DISTANCE--MARS,RETURN
CLASS    IN---C.0---A
BON= 0.2153E 01      RPERN(1)= 0.1523E 01      DVON= 0.2152E-00
```

RN	DELRPN	P	Q
0.2347E 03	0.1045E 01	0.7409E 03	0.1000E 01
0.1318E 02	0.5695E-01	0.4039E 02	0.5451E-01
0.2484E 02	0.1084E-00	0.7687E 02	0.1038E-00
0.3650E 02	0.1598E-00	0.1133E 03	0.1529E-00
0.4816E 02	0.2112E-00	0.1498E 03	0.2022E-00
0.5982E 02	0.2627E-00	0.1863E 03	0.2515E-00
0.7147E 02	0.3143E-00	0.2229E 03	0.3009E-00
0.8313E 02	0.3660E-00	0.2596E 03	0.3504E-00
0.9479E 02	0.4178E-00	0.2963E 03	0.3999E-00
0.1064E 03	0.4697E-00	0.3331E 03	0.4496E-00
0.1181E 03	0.5217E 00	0.3700E 03	0.4993E-00
0.1298E 03	0.5737E 00	0.4069E 03	0.5491E 00
0.1414E 03	0.6258E 00	0.4438E 03	0.5990E 00
0.1531E 03	0.6779E 00	0.4808E 03	0.6489E 00
0.1647E 03	0.7302E 00	0.5178E 03	0.6989E 00
0.1764E 03	0.7825E 00	0.5549E 03	0.7490E 00
0.1881E 03	0.8348E 00	0.5921E 03	0.7991E 00
0.1997E 03	0.8872E 00	0.6292E 03	0.8492E 00
0.2114E 03	0.9397E 00	0.6664E 03	0.8994E 00
0.2230E 03	0.9922E 00	0.7037E 03	0.9497E 00

```
M=1  FQ= 0.5002E 00       FM= 0.1999E C1      NOPT= 1
 N   RED. FACTOR      MULT.FACTOR     SUM/W            SUM/29.8
 1    0.5002E 00      0.1999E 01      0.1999E 01       0.6708E-C1

M=2  FQ= 0.20C1E-00       FM= 0.4998E C1      NOPT= 3
 N   RED. FACTOR      MULT.FACTOR     SUM/W            SUM/29.8
 3    0.5849E 00      0.1710E 01      0.2961E 01       0.9937E-C1
 2    0.4473E-00      0.2236E 01      0.3162E 01       0.1061E-C0
 1    0.2001E-00      0.4998E 01      0.4998E 01       0.1677E-C0

M=3  FQ= 0.1000E-00       FM= 0.9995E C1      NOPT= 5
 N   RED. FACTOR      MULT.FACTOR     SUM/W            SUM/29.8
 5    0.631CE 00      0.1585E 01      0.3544E 01       0.1189E-00
 4    0.5624E 0C      0.1778E 01      0.3556E 01       0.1193E-00
 3    0.4642E-00      0.2154E 01      0.3731E 01       0.1252E-00
 2    0.3163E-00      0.3162E 01      0.4471E 01       0.1500E-C0
 1    0.100CE-00      0.9995E 01      0.9995E 01       0.3354E-00

M=4  FQ= C.6670E-01       FM= 0.1499E C2      NOPT= 5
 N   RED. FACTOR      MULT.FACTOR     SUM/W            SUM/29.8
 5    0.5819E 00      0.1719E 01      0.3843E 01       0.1290E-00
 4    0.5082E 00      0.1968E 01      0.3936E 01       C.1321E-00
 3    0.4055E-00      0.2466E 01      0.4271E 01       C.1433E-C0
 2    0.2583E-00      0.3872E 01      0.5476E 01       C.1838E-00
 1    0.667CE-01      C.1499E 02      0.1499E 02       0.5031E 00

M=5  FQ= 0.50C2E-01       FM= 0.1999E C2      NOPT= 6
 N   RED. FACTOR      MULT.FACTOR     SUM/W            SUM/29.8
 6    0.607CE 00      C.1647E 01      0.4C35E 01       0.1354E-00
 5    C.5493E 00      0.1820E 01      0.4071E 01       0.1366E-00
 4    0.4729E-00      0.2114E 01      0.4229E 01       C.1419E-C0
 3    0.3685E-00      0.2714E 01      0.4701E 01       C.1577E-C0
 2    0.2237E-00      C.4471E 01      0.6323E 01       C.2122E-00
```

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---A MARS-OPT-RETURN
2 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.2708E 04	0.
1	0.5368E 02	0.6023E 03	0.2106E 04
2	0.1319E 02	0.1389E 03	0.4634E 03

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---A MARS-OPT-RETURN
4 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.2708E 04	0.
1	0.1118E 03	0.1276E 04	0.1432E 04
2	0.5367E 02	0.6021E 03	0.6741E 03
3	0.2618E 02	0.2861E 03	0.3160E 03
4	0.1318E 02	0.1388E 03	0.1473E 03

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---A MARS-OPT-RETURN
6 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.2708E 04	0.
1	0.1431E 03	0.1640E 04	0.1068E 04
2	0.8744E 02	0.9932E 03	0.6468E 03
3	0.5367E 02	0.6021E 03	0.3911E 03
4	0.3318E 02	0.3661E 03	0.2360E 03
5	0.2074E 02	0.2241E 03	0.1420E 03
6	0.1319E 02	0.1388E 03	0.8527E 02

COMPARISON OF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS IN---C.O---A MARS, RETURN
BON= 0.1644E 01 AON= 0.7613E 00 ECCO= 0.2380E 01
TRANSVERSE ERROR

RN	DELRPN	P	Q
0.2347E 03	0.1024E 01	0.7259E C3	0.1000E 01
0.4778E 02	0.2C29E-00	0.1439E C3	0.1982E-00
0.9451E 02	0.4048E-00	0.2871E 03	0.3955E-00
0.1412E 03	0.6093E 00	0.4321E C3	0.5953E 00
0.1880E 03	0.8157E 00	0.5785E C3	0.7969E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.2347E C3	0.4041E-02	0.2866E C1	0.1000E 01
0.4778E 02	0.3920E-02	0.2780E C1	0.9702E 00
0.9451E 02	0.3994E-02	0.2833E C1	0.9886E 00
0.1412E 03	0.4020E-02	0.2851E 01	0.9949E 00
0.1880E 03	0.4033E-02	0.2860E C1	0.9981E 00

VARIATIONS CN PERI-APSIS DISTANCE--MARS,RETURN
CLASS IN---0.0---A
BCN= 0.1644E C1 RPERN(2)= 0.105CE 01 DVON= 0.2173E-00

RN	DELRPN	P	C
0.2347E 03	0.1C24E C1	C.7259E C3	0.100CE 01
0.1273E 02	0.5327E-01	0.3778E C2	0.5205E-01
0.2441E 02	0.1C30E-00	0.73C4E C2	0.1006E-00
C.3610E 02	0.1528E-00	0.1084E C3	0.1493E-00
0.4778E 02	0.2C29E-C0	C.1439E C3	0.1982E-00
0.5946E 02	0.2531E-0C	C.1795E C3	0.2473E-00
0.7114E 02	0.3035E-00	C.2152E C3	0.2965E-00
0.8283E 02	0.3541E-00	0.2511E C3	0.3459E-00
0.9451E 02	0.4C48E-00	C.2871E C3	0.3955E-00
0.1062E 03	0.4557E-00	0.3232E C3	0.4453E-00
0.1179E 03	0.5C68E C0	0.3594E C3	0.4951E-00
0.1296E 03	0.5580E C0	C.3957E C3	0.5451E 00
0.1412E 03	0.6093E 00	C.4321E C3	0.5953E 00
0.1529E 03	0.6607E 00	0.4686E C3	0.6455E 00
0.1646E 03	0.7123E 00	0.5051E C3	0.6959E 00
C.1763E 03	0.7639E 00	C.5418E C3	0.7463E 00
0.1880E 03	0.8157E 00	0.5785E C3	0.7969E 00
0.1996E 03	0.8675E 00	0.6152E C3	0.8476E 00
0.2113E 03	0.9194E 00	0.6521E C3	0.8983E 00
0.2230E 03	0.9714E C0	0.6890E C3	0.9491E 00

M=1 FQ= 0.4908E-01 FM= 0.2037E 02 NOPT= 6

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
6	0.6051E 00	0.1653E 01	0.4048E 01	0.1358E-00
5	0.5472E 00	0.1827E 01	0.4086E 01	0.1371E-00
4	0.4707E-00	0.2125E 01	0.4249E 01	0.1426E-00
3	0.3661E-00	0.2731E 01	0.4731E 01	0.1587E-00
2	0.2215E-00	0.4514E 01	0.6384E 01	0.2142E-00

M=2 FQ= 0.1963E-01 FM= 0.5094E 02 NOPT= 8

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
8	0.6118E 00	0.1634E 01	0.4623E 01	0.1551E-00
7	0.5703E 00	0.1753E 01	0.4639E 01	0.1557E-00
6	0.5194E 00	0.1925E 01	0.4716E 01	0.1583E-00
5	0.4556E-00	0.2195E 01	0.4908E 01	0.1647E-00
4	0.3743E-00	0.2672E 01	0.5343E 01	0.1793E-00

M=3 FQ= 0.9816E-02 FM= 0.1019E 03 NOPT= 9

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
9	0.5982E 00	0.1672E 01	0.5015E 01	0.1683E-00
8	0.5610E 00	0.1782E 01	0.5041E 01	0.1692E-00
7	0.5166E 00	0.1936E 01	0.5122E 01	0.1719E-00
6	0.4627E-00	0.2161E 01	0.5294E 01	0.1776E-00
5	0.3966E-00	0.2521E 01	0.5638E 01	0.1892E-00

M=4 FQ= 0.6544E-02 FM= 0.1528E 03 NOPT=10

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
10	0.6048E 00	0.1654E 01	0.5229E 01	0.1755E-00
9	0.5719E 00	0.1749E 01	0.5246E 01	0.1760E-00
8	0.5333E 00	0.1875E 01	0.5304E 01	0.1780E-00
7	0.4875E-00	0.2051E 01	0.5427E 01	0.1821E-00
6	0.4325E-00	0.2312E 01	0.5664E 01	0.1901E-00

M=5 FQ= 0.4908E-02 FM= 0.2037E 03 NOPT=11

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
11	0.6167E 00	0.1622E 01	0.5378E 01	0.1805E-00
10	0.5876E 00	0.1702E 01	0.5382E 01	0.1806E-00
9	0.5539E 00	0.1805E 01	0.5416E 01	0.1817E-00
8	0.5145E 00	0.1944E 01	0.5498E 01	0.1845E-00
7	0.4679E-00	0.2137E 01	0.5655E 01	0.1898E-00

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---A MARS-CLOSE-RETURN
7 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.2706E 04	0.
1	0.1104E 03	0.1258E 04	0.1449E 04
2	0.5220E 02	0.5833E 03	0.6744E 03
3	0.2498E 02	0.2708E 03	0.3125E 03
4	0.1225E 02	0.1271E 03	0.1437E 03
5	0.6290E 01	0.6163E 02	0.6547E 02
6	0.3502E 01	0.3180E 02	0.2983E 02
7	0.2197E 01	0.1781E 02	0.1398E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---A MARS-CLOSE-RETURN
9 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.2706E 04	0.
1	0.1305E 03	0.1491E 04	0.1215E 04
2	0.7274E 02	0.8208E 03	0.6707E 03
3	0.4076E 02	0.4514E 03	0.3694E 03
4	0.2304E 02	0.2487E 03	0.2027E 03
5	0.1323E 02	0.1381E 03	0.1106E 03
6	0.7798E 01	0.7800E 02	0.6005E 02
7	0.4788E 01	0.4548E 02	0.3251E 02
8	0.3120E 01	0.2774E 02	0.1774E 02
9	0.2197E 01	0.1781E 02	0.9934E 01

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---A MARS-CLOSE-RETURN
11 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.2706E 04	0.
1	0.1454E 03	0.1665E 04	0.1042E 04
2	0.9017E 02	0.1023E 04	0.6417E 03
3	0.5609E 02	0.6282E 03	0.3948E 03
4	0.3504E 02	0.3858E 03	0.2424E 03
5	0.2204E 02	0.2374E 03	0.1484E 03
6	0.1402E 02	0.1468E 03	0.9054E 02
7	0.9058E 01	0.9180E 02	0.5502E 02
8	0.5996E 01	0.5845E 02	0.3335E 02
9	0.4104E 01	0.3820E 02	0.2025E 02
10	0.2936E 01	0.2579E 02	0.1242E 02
11	0.2215E 01	0.1801E 02	0.7775E 01

COMPARISON CF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS IN---C.O---B MARS, RETURN
BON= 0.2217E C1 AON= 0.7837E 00 ECCO= 0.300CE 01

TRANSVERSE ERROR

RN	DELRPN	P	Q
0.2347E 03	0.1060E 01	0.7516E 03	0.1000E 01
0.4819E 02	0.2144E-00	0.1521E C3	0.2023E-00
0.9482E 02	0.4240E-00	0.3007E C3	0.4001E-00
0.1414E 03	0.6349E C0	0.45C3E 03	0.5991E 00
0.1881E 03	0.8469E 00	0.60C6E C3	0.7991E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.2347E 03	0.4838E-02	0.3431E 01	0.1000E 01
0.4819E 02	0.4652E-02	0.3299E 01	0.9617E 00
0.9482E 02	0.4766E-02	0.3380E C1	0.9853E 00
0.1414E 03	0.4806E-02	0.3408E C1	0.9934E 00
0.1881E 03	0.4826E-02	0.3422E C1	0.9975E 00

VARIATIONS CN PERI-APSIS DISTANCE--MARS,RETURN
CLASS IN---C.O---B
BON= 0.2217E C1 RPERN(1)= 0.1567E 01 DVON= 0.2121E-CO

RN	DELRPN	P	Q
0.2347E 03	0.1C60E 01	0.7516E C3	0.1000E 01
0.1322E 02	0.5793E-01	0.41C8E C2	0.5466E-01
0.2488E 02	0.1101E-00	C.7810E C2	0.1039E-00
0.3654E 02	0.1622E-00	0.1151E C3	0.1531E-00
0.4819E 02	0.2144E-00	0.1521E C3	0.2023E-00
0.5985E 02	0.2667E-00	0.1891E C3	0.2516E-00
0.7151E 02	0.3190E-00	0.2263E C3	0.3010E-00
0.8316E 02	0.3715E-00	0.2635E C3	0.3505E-00
0.9482E 02	0.4240E-00	0.3007E C3	0.4001E-00
0.1065E 03	0.4766E-00	0.3380E C3	0.4497E-00
0.1181E 03	0.5293E 00	0.3754E C3	0.4994E-00
0.1298E 03	0.5821E C0	0.4128E C3	0.5492E 00
0.1414E 03	0.6349E 00	0.45C3E C3	0.5991E 00
0.1531E 03	0.6878E 00	0.4878E C3	0.6490E 00
0.1648E 03	0.7408E 00	C.5254E C3	0.6990E 00
0.1764E 03	0.7938E 00	0.5630E C3	0.7490E 00
0.1881E 03	0.8469E 00	0.60C6E C3	0.7991E 00
0.1997E 03	0.9C00E 00	0.6383E C3	0.8493E 00
0.2114E 03	0.9532E 00	0.6760E C3	0.8995E 00
0.2230E 03	0.1C06E 01	0.7138E C3	0.9497E 00

M=1 FQ= 0.5354E 00 FM= 0.1868E C1 NOPT= 1

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
1	0.5354E 00	0.1868E 01	0.1868E 01	0.6268E-01

M=2 FQ= 0.2141E-00 FM= 0.4670E C1 NOPT= 3

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
3	0.5983E 00	0.1671E 01	0.2895E 01	0.9715E-01
2	0.4628E-00	0.2161E 01	0.3056E 01	0.1026E-00
1	0.2141E-00	0.4670E 01	0.4670E 01	C.1567E-00

M=3 FQ= 0.1071E-00 FM= 0.9339E C1 NOPT= 4

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
4	0.5720E 00	0.1748E 01	0.3496E 01	0.1173E-00
3	0.4749E-00	C.2106E 01	0.3648E 01	0.1224E-00
2	0.3272E-00	0.3056E 01	0.4322E 01	C.1450E-00
1	0.1071E-00	0.9339E 01	0.9339E 01	0.3134E-00

M=4 FQ= 0.7138E-01 FM= 0.1401E 02 NOPT= 5

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
5	0.5898E 00	0.1695E 01	0.3791E 01	C.1272E-00
4	0.5169E 00	0.1935E 01	0.3869E 01	0.1298E-00
3	0.4148E-00	0.2411E 01	0.4175E 01	0.1401E-00
2	0.2672E-00	C.3743E 01	0.5293E 01	0.1776E-00
1	0.7138E-01	C.1401E 02	0.1401E 02	0.4701E-00

M=5 FQ= 0.5354E-01 FM= 0.1868E C2 NOPT= 6

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
6	0.6139E 00	0.1629E 01	0.3990E 01	C.1339E-00
5	0.5568E 00	0.1796E 01	0.4016E 01	0.1348E-00
4	0.4810E-00	0.2079E 01	0.4158E 01	0.1395E-00
3	0.3769E-00	0.2653E 01	0.4596E 01	C.1542E-00
2	0.2314E-00	0.4322E 01	0.6112E 01	C.2051E-00

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---B MARS-OPT-RETURN
2 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.2747E 04	0.
1	0.5551E 02	0.6320E 03	0.2115E 04
2	0.1405E 02	0.1504E 03	0.4816E 03

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---B MARS-OPT-RETURN
4 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.2747E 04	0.
1	0.1137E 03	0.1317E 04	0.1430E 04
2	0.5550E 02	0.6319E 03	0.6848E 03
3	0.2751E 02	0.3053E 03	0.3266E 03
4	0.1405E 02	0.1503E 03	0.1549E 03

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---B MARS-OPT-RETURN
6 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.2747E 04	0.
1	0.1447E 03	0.1682E 04	0.1065E 04
2	0.8943E 02	0.1031E 04	0.6519E 03
3	0.5551E 02	0.6319E 03	0.3987E 03
4	0.3468E 02	0.3885E 03	0.2433E 03
5	0.2189E 02	0.2403E 03	0.1482E 03
6	0.1405E 02	0.1504E 03	0.8999E 02

COMPARISON OF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS IN---C.0---B MARS, RETURN
BCN= 0.1658E 01 AUN= 0.7837E 00 ECCC= 0.2340E 01

TRANSVERSE ERROR

RN	DELRPN	P	Q
0.2347E 03	0.1036E 01	0.7349E 03	0.1000E 01
0.4778E 02	0.2052E-00	0.1455E 03	0.1980E-00
0.9451E 02	0.4095E-00	0.2905E 03	0.3952E-00
0.1412E 03	0.6166E 00	0.4373E 03	0.5950E 00
0.1880E 03	0.8256E 00	0.5855E 03	0.7968E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.2347E 03	0.4168E-02	0.2956E 01	0.1000E 01
0.4778E 02	0.4042E-02	0.2867E 01	0.9698E 00
0.9451E 02	0.4120E-02	0.2922E 01	0.9884E 00
0.1412E 03	0.4147E-02	0.2941E 01	0.9948E 00
0.1880E 03	0.4160E-02	0.2950E 01	0.9981E 00

VARIATIONS ON PERI-APSIS DISTANCE--MARS,RETURN
CLASS IN---C.0---B
BCN= 0.1658E 01 RPERN(2)= 0.1050E 01 DVON= 0.2145E-00

RN	DELRPN	P	Q
0.2347E 03	0.1036E 01	0.7349E 03	0.1000E 01
0.1273E 02	0.5386E-01	0.3820E 02	0.5198E-01
0.2441E 02	0.1041E-00	0.7385E 02	0.1005E-00
0.3610E 02	0.1545E-00	0.1096E 03	0.1491E-00
0.4778E 02	0.2052E-00	0.1455E 03	0.1980E-00
0.5946E 02	0.2560E-00	0.1815E 03	0.2470E-00
0.7114E 02	0.3070E-00	0.2177E 03	0.2963E-00
0.8283E 02	0.3582E-00	0.2540E 03	0.3457E-00
0.9451E 02	0.4095E-00	0.2905E 03	0.3952E-00
0.1062E 03	0.4611E-00	0.3270E 03	0.4450E-00
0.1179E 03	0.5128E 00	0.3637E 03	0.4949E-00
0.1296E 03	0.5646E 00	0.4004E 03	0.5449E 00
0.1412E 03	0.6166E 00	0.4373E 03	0.5950E 00
0.1529E 03	0.6686E 00	0.4742E 03	0.6453E 00
0.1646E 03	0.7208E 00	0.5112E 03	0.6957E 00
0.1763E 03	0.7732E 00	0.5483E 03	0.7462E 00
0.1880E 03	0.8256E 00	0.5855E 03	0.7968E 00
0.1996E 03	0.8781E 00	0.6228E 03	0.8474E 00
0.2113E 03	0.9307E 00	0.6601E 03	0.8982E 00
0.2230E 03	0.9834E 00	0.6974E 03	0.9491E 00

M=1 FQ= 0.4848E-01 FM= 0.2063E 02 NOPT= 6

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
6	0.6039E 00	0.1656E 01	0.4056E 01	0.1361E-00
5	0.5459E 00	0.1832E 01	0.4096E 01	0.1375E-00
4	0.4692E-00	0.2131E 01	0.4262E 01	0.1430E-00
3	0.3646E-00	0.2742E 01	0.4750E 01	0.1594E-00
2	0.2202E-00	0.4542E 01	0.6423E 01	0.2155E-00

M=2 FQ= 0.1939E-01 FM= 0.5157E 02 NOPT= 8

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
8	0.6109E 00	0.1637E 01	0.4630E 01	0.1554E-00
7	0.5693E 00	0.1756E 01	0.4647E 01	0.1559E-00
6	0.5183E 00	0.1929E 01	0.4726E 01	0.1586E-00
5	0.4545E-00	0.2200E 01	0.4920E 01	0.1651E-00
4	0.3732E-00	0.2680E 01	0.5359E 01	0.1798E-00

M=3 FQ= 0.9696E-02 FM= 0.1031E 03 NOPT= 9

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
9	0.5974E 00	0.1674E 01	0.5021E 01	0.1685E-00
8	0.5602E 00	0.1785E 01	0.5049E 01	0.1694E-00
7	0.5157E 00	0.1939E 01	0.5131E 01	0.1722E-00
6	0.4618E-00	0.2166E 01	0.5304E 01	0.1780E-00
5	0.3957E-00	0.2527E 01	0.5652E 01	0.1896E-00

M=4 FQ= 0.6464E-02 FM= 0.1547E 03 NOPT=10

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
10	0.6040E 00	0.1656E 01	0.5235E 01	0.1757E-00
9	0.5711E 00	0.1751E 01	0.5253E 01	0.1763E-00
8	0.5325E 00	0.1878E 01	0.5312E 01	0.1782E-00
7	0.4866E-00	0.2055E 01	0.5437E 01	0.1824E-00
6	0.4316E-00	0.2317E 01	0.5675E 01	0.1904E-00

M=5 FQ= 0.4848E-02 FM= 0.2063E 03 NOPT=11

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
11	0.6160E 00	0.1623E 01	0.5384E 01	0.1807E-00
10	0.5869E 00	0.1704E 01	0.5388E 01	0.1808E-00
9	0.5531E 00	0.1808E 01	0.5423E 01	0.1820E-00
8	0.5137E 00	0.1947E 01	0.5506E 01	0.1848E-00
7	0.4671E-00	0.2141E 01	0.5665E 01	0.1901E-00

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---B MARS-CLOSE-RETURN

7 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.2745E 04	0.
1	0.1102E 03	0.1273E 04	0.1472E 04
2	0.5203E 02	0.5891E 03	0.6840E 03
3	0.2486E 02	0.2728E 03	0.3163E 03
4	0.1217E 02	0.1277E 03	0.1451E 03
5	0.6245E 01	0.6179E 02	0.6592E 02
6	0.3477E 01	0.3184E 02	0.2995E 02
7	0.2184E 01	0.1782E 02	0.1401E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---B MARS-CLOSE-RETURN

9 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.2745E 04	0.
1	0.1303E 03	0.1510E 04	0.1235E 04
2	0.7253E 02	0.8296E 03	0.6806E 03
3	0.4058E 02	0.4553E 03	0.3742E 03
4	0.2292E 02	0.2504E 03	0.2050E 03
5	0.1314E 02	0.1387E 03	0.1117E 03
6	0.7739E 01	0.7820E 02	0.6048E 02
7	0.4750E 01	0.4554E 02	0.3267E 02
8	0.3096E 01	0.2775E 02	0.1779E 02
9	0.2182E 01	0.1781E 02	0.9944E 01

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---B MARS-CLOSE-RETURN

11 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.2745E 04	0.
1	0.1450E 03	0.1684E 04	0.1061E 04
2	0.8971E 02	0.1032E 04	0.6520E 03
3	0.5566E 02	0.6316E 03	0.4000E 03
4	0.3469E 02	0.3867E 03	0.2449E 03
5	0.2177E 02	0.2372E 03	0.1495E 03
6	0.1382E 02	0.1463E 03	0.9092E 02
7	0.8914E 01	0.9122E 02	0.5506E 02
8	0.5894E 01	0.5795E 02	0.3326E 02
9	0.4034E 01	0.3782E 02	0.2013E 02
10	0.2888E 01	0.2551E 02	0.1231E 02
11	0.2182E 01	0.1781E 02	0.7697E 01

COMPARISON CF LCNGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS IN---C.O---C MARS, RETURN
BCN= 0.1599E C1 AON= 0.5655E 00 ECCO= 0.300CE 01
TRANSVERSE ERROR

RN	DELRPN	P	Q
C.2347E 03	0.9022E 00	C.6399E C3	0.1000E 01
C.4784E 02	0.1811E-CO	C.1284E C3	0.2007E-00
0.9456E 02	0.3597E-00	0.2551E C3	0.3987E-00
0.1413E 03	0.5396E 00	0.3827E 03	0.5981E 00
0.1880E 03	0.7205E 00	0.5110E C3	0.7986E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
C.2347E C3	0.2976E-02	0.2110E C1	0.1000E 01
0.4784E 02	0.2892E-02	0.2051E C1	0.9720E 00
0.9456E 02	0.2944E-C2	0.2088E C1	0.9893E 00
0.1413E 03	0.2962E-02	0.21COE C1	0.9952E 00
0.1880E 03	0.2970E-02	0.21C7E C1	0.9982E 00

VARIATIONS CN PERI-APSIS DISTANCE--MARS,RETURN
CLASS IN---C.C---C
BON= 0.1599E C1 RPERN(1)= 0.1131E 01 DVON= C.2497E-C0

RN	DELRPN	P	Q
0.2347E 03	0.9C22E C0	0.6399E C3	0.1C00E 01
0.1281E 02	0.4794E-01	0.34C0E C2	0.5314E-01
0.2449E 02	0.9227E-01	0.6544E C2	0.1023E-00
0.3617E 02	0.1366E-C0	0.9689E C2	0.1514E-00
0.4784E 02	0.1811E-00	0.1284E C3	0.2007E-00
0.5952E 02	0.2256E-C0	C.16C0E C3	0.2500E-00
0.7120E 02	0.2702E-00	0.1916E C3	0.2995E-00
0.8288E 02	0.3149E-00	0.2233E C3	0.3491E-00
0.9456E 02	0.3597E-00	0.2551E C3	0.3987E-00
0.1C62E 03	0.4C46E-00	0.2869E C3	0.4484E-00
0.1179E 03	0.4495E-00	C.3188E C3	0.4982E-00
0.1296E 03	0.4945E-00	0.35C7E C3	0.5481E 00
0.1413E 03	0.5396E 00	0.3827E C3	0.5981E 00
0.1529E 03	0.5847E 00	0.4147E C3	0.6481E 00
0.1646E 03	0.6299E CC	0.4468E C3	0.6982E 00
0.1763E 03	0.6752E 00	0.4789E C3	0.7484E 00
0.1880E 03	0.7205E 00	C.5110E C3	0.7986E 00
0.1997E 03	0.7659E 00	0.5432F C3	0.8489E 00
0.2113E C3	0.8113E 00	C.5754E C3	0.8992E 00
0.2230E 03	0.8567E C0	0.6076E C3	0.9496E 00

M=1	FQ= 0.1452E-00	FM= 0.6889E 01	NOPT= 4	
N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
4	0.6172E 00	0.1620E 01	0.3240E 01	0.1087E-00
3	0.5255E 00	0.1903E 01	0.3296E 01	0.1106E-00
2	0.3810E-00	0.2625E 01	0.3712E 01	0.1246E-00
1	0.1452E-00	0.6889E 01	0.6889E 01	0.2312E-00

M=2	FQ= 0.5806E-01	FM= 0.1722E 02	NOPT= 6	
N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
6	0.6223E 00	0.1607E 01	0.3936E 01	0.1321E-00
5	0.5660E 00	0.1767E 01	0.3951E 01	0.1326E-00
4	0.4909E-00	0.2037E 01	0.4074E 01	0.1367E-00
3	0.3872E-00	0.2582E 01	0.4473E 01	0.1501E-00
2	0.2410E-00	0.4150E 01	0.5869E 01	0.1969E-00

M=3	FQ= 0.2903E-01	FM= 0.3445E 02	NOPT= 7	
N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
7	0.6031E 00	0.1658E 01	0.4387E 01	0.1472E-00
6	0.5544E 00	0.1804E 01	0.4418E 01	0.1483E-00
5	0.4927E-00	0.2030E 01	0.4539E 01	0.1523E-00
4	0.4128E-00	0.2423E 01	0.4845E 01	0.1626E-00
3	0.3073E-00	0.3254E 01	0.5636E 01	0.1891E-00

M=4	FQ= 0.1935E-01	FM= 0.5167E 02	NOPT= 8	
N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
8	0.6107E 00	0.1637E 01	0.4631E 01	0.1554E-00
7	0.5692E 00	0.1757E 01	0.4648E 01	0.1560E-00
6	0.5182E 00	0.1930E 01	0.4727E 01	0.1586E-00
5	0.4543E-00	0.2201E 01	0.4922E 01	0.1652E-00
4	0.3730E-00	0.2681E 01	0.5362E 01	0.1799E-00

M=5	FQ= 0.1452E-01	FM= 0.6889E 02	NOPT= 8	
N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
8	0.5892E 00	0.1697E 01	0.4801E 01	0.1611E-00
7	0.5463E 00	0.1831E 01	0.4843E 01	0.1625E-00
6	0.4939E-00	0.2025E 01	0.4959E 01	0.1664E-00
5	0.4289E-00	0.2331E 01	0.5213E 01	0.1749E-00
4	0.3471E-00	0.2881E 01	0.5762E 01	0.1934E-00

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---C MARS-OPT-RETURN
4 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.2341E 04	0.
1	0.8220E 02	0.8086E 03	0.1532E 04
2	0.2927E 02	0.2802E 03	0.5284E 03
3	0.1090E 02	0.9955E 02	0.1806E 03
4	0.4521E 01	0.3832E 02	0.6123E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---C MARS-OPT-RETURN
6 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.2341E 04	0.
1	0.1165E 03	0.1153E 04	0.1189E 04
2	0.5811E 02	0.5675E 03	0.5851E 03
3	0.2927E 02	0.2802E 03	0.2873E 03
4	0.1503E 02	0.1398E 03	0.1404E 03
5	0.7996E 01	0.7152E 02	0.6827E 02
6	0.4521E 01	0.3832E 02	0.3319E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---C MARS-OPT-RETURN
8 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.2341E 04	0.
1	0.1387E 03	0.1376E 04	0.9650E 03
2	0.8222E 02	0.8088E 03	0.5674E 03
3	0.4891E 02	0.4756E 03	0.3332E 03
4	0.2928E 02	0.2803E 03	0.1953E 03
5	0.1772E 02	0.1661E 03	0.1142E 03
6	0.1090E 02	0.9959E 02	0.6653E 02
7	0.6889E 01	0.6090E 02	0.3869E 02
8	0.4523E 01	0.3834E 02	0.2256E 02

COMPARISON CF LONGITUDINAL AND TRANSVERSE VELOCITY ERRORS
CLASS IN---0.0---C MARS, RETURN
BON= 0.1514E C1 AON= 0.5655E 00 ECCO= 0.2857E 01
TRANSVERSE ERROR

RN	DELRPN	P	Q
0.2347E 03	0.8992E 00	0.6377E C3	0.1000E 01
0.4778E 02	0.1798E-00	0.1275E C3	0.2000E-00
0.9451E 02	0.3578E-00	0.2538E C3	0.3979E-00
0.1412E 03	0.5372E 00	0.3810E C3	0.5975E 00
0.1880E 03	0.7178E 00	0.5090E C3	0.7982E 00

LONGITUDINAL ERROR

RN	DELRPN	P	Q
0.2347E 03	0.2903E-02	0.2059E C1	0.1000E 01
0.4778E 02	0.2825E-02	0.2004E 01	0.9733E 00
0.9451E 02	0.2873E-02	0.2038E C1	0.9898E 00
0.1412E 03	0.2889E-02	0.2049E C1	0.9954E 00
0.1880E 03	0.2898E-02	0.2055E C1	0.9983E 00

VARIATIONS CN PERI-APSIS DISTANCE--MARS,RETURN
CLASS IN---0.0---C
BON= 0.1514E C1 RPERN(2)= 0.1050E 01 DVON= 0.2498E-00

RN	DELRPN	P	Q
0.2347E 03	0.8992E 00	0.6377E C3	0.1000E 01
0.1273E 02	0.4740E-01	0.3361E C2	0.5271E-01
0.2441E 02	0.9147E-01	0.6487E C2	0.1017E-00
0.3610E 02	0.1356E-00	0.9617E C2	0.1508E-00
0.4778E 02	0.1798E-00	0.1275E 03	0.2000E-00
0.5946E 02	0.2242E-00	0.1590E C3	0.2493E-00
0.7114E 02	0.2686E-00	0.1905E C3	0.2987E-00
0.8283E 02	0.3132E-00	0.2221E C3	0.3483E-00
0.9451E 02	0.3578E-00	0.2538E C3	0.3979E-00
0.1062E 03	0.4025E-00	0.2855E C3	0.4477E-00
0.1179E 03	0.4474E-00	0.3173E C3	0.4975E-00
0.1296E 03	0.4923E-00	0.3491E 03	0.5475E 00
0.1412E 03	0.5372E 00	0.3810E C3	0.5975E 00
0.1529E 03	0.5823E 00	0.4130E C3	0.6476E 00
0.1646E 03	0.6274E 00	0.4449E C3	0.6977E 00
0.1763E 03	0.6725E 00	0.4770E C3	0.7480E 00
0.1880E 03	0.7178E 00	0.5090E C3	0.7982E 00
0.1996E 03	0.7630E 00	0.5412E 03	0.8486E 00
0.2113E 03	0.8084E 00	0.5733E C3	0.8990E 00
0.2230E 03	0.8537E 00	0.6055E C3	0.9495E 00

M=1 FQ= 0.5587E-01 FM= 0.1790E 02 NOPT= 6

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
6	0.6183E 00	0.1617E 01	0.3962E 01	0.1329E-00
5	0.5616E 00	0.1781E 01	0.3982E 01	0.1336E-00
4	0.4862E-00	0.2057E 01	0.4114E 01	0.1380E-00
3	0.3823E-00	0.2616E 01	0.4531E 01	0.1520E-00
2	0.2364E-00	0.4231E 01	0.5983E 01	0.2008E-00

M=2 FQ= 0.2235E-01 FM= 0.4475E 02 NOPT= 8

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
8	0.6218E 00	0.1608E 01	0.4549E 01	0.1526E-00
7	0.5810E 00	0.1721E 01	0.4554E 01	0.1528E-00
6	0.5307E 00	0.1884E 01	0.4615E 01	0.1549E-00
5	0.4676E-00	0.2139E 01	0.4782E 01	0.1605E-00
4	0.3866E-00	0.2586E 01	0.5173E 01	0.1736E-00

M=3 FQ= 0.1117E-01 FM= 0.8949E 02 NOPT= 9

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
9	0.6069E 00	0.1648E 01	0.4943E 01	0.1659E-00
8	0.5702E 00	0.1754E 01	0.4960E 01	0.1665E-00
7	0.5262E 00	0.1900E 01	0.5028E 01	0.1687E-00
6	0.4728E-00	0.2115E 01	0.5181E 01	0.1738E-00
5	0.4070E-00	0.2457E 01	0.5493E 01	0.1843E-00

M=4 FQ= 0.7449E-02 FM= 0.1342E 03 NOPT=10

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
10	0.6126E 00	0.1632E 01	0.5162E 01	0.1732E-00
9	0.5802E 00	0.1724E 01	0.5171E 01	0.1735E-00
8	0.5420E 00	0.1845E 01	0.5218E 01	0.1751E-00
7	0.4966E-00	0.2014E 01	0.5328E 01	0.1788E-00
6	0.4419E-00	0.2263E 01	0.5543E 01	0.1860E-00

M=5 FQ= 0.5587E-02 FM= 0.1790E 03 NOPT=10

N	RED. FACTOR	MULT.FACTOR	SUM/W	SUM/29.8
10	0.5953E 00	0.1680E 01	0.5312E 01	0.1783E-00
9	0.5619E 00	0.1780E 01	0.5339E 01	0.1792E-00
8	0.5229E 00	0.1913E 01	0.5409E 01	0.1815E-00
7	0.4766E-00	0.2098E 01	0.5551E 01	0.1863E-00
6	0.4212E-00	0.2374E 01	0.5815E 01	0.1951E-00

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---C MARS-CLOSE-RETURN
6 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.2341E 04	0.
1	0.9946E 02	0.9814E 03	0.1359E 04
2	0.4250E 02	0.4115E 03	0.5700E 03
3	0.1851E 02	0.1737E 03	0.2378E 03
4	0.8404E 01	0.7531E 02	0.9839E 02
5	0.4147E 01	0.3478E 02	0.4054E 02
6	0.2355E 01	0.1770E 02	0.1707E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---C MARS-CLOSE-RETURN
8 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.2341E 04	0.
1	0.1232E 03	0.1220E 04	0.1121E 04
2	0.6494E 02	0.6355E 03	0.5845E 03
3	0.3446E 02	0.3314E 03	0.3041E 03
4	0.1852E 02	0.1738E 03	0.1576E 03
5	0.1018E 02	0.9247E 02	0.8131E 02
6	0.5826E 01	0.5068E 02	0.4180E 02
7	0.3547E 01	0.2910E 02	0.2157E 02
8	0.2356E 01	0.1772E 02	0.1139E 02

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0,0---C MARS-CLOSE-RETURN
10 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
0	0.2347E 03	0.2341E 04	0.
1	0.1401E 03	0.1390E 04	0.9510E 03
2	0.8385E 02	0.8249E 03	0.5650E 03
3	0.5034E 02	0.4896E 03	0.3352E 03
4	0.3039E 02	0.2911E 03	0.1986E 03
5	0.1852E 02	0.1738E 03	0.1173E 03
6	0.1145E 02	0.1047E 03	0.6907E 02
7	0.7240E 01	0.6416E 02	0.4056E 02
8	0.4735E 01	0.4033E 02	0.2383E 02
9	0.3244E 01	0.2623E 02	0.1410E 02
10	0.2356E 01	0.1772E 02	0.8510E 01

Program 3

(Variable Magnitude Corrective Impulse Error Analysis)

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GRH MULTI-STEP OPTIMIZATION PROBLEM

      DIMENSION TITLE1(12),TITLE2(12),RPER(5),R(510),
     1DDV(510),FOPT1(510),FOPT2(510),RR1(510,15),ROPTS(15),
     2RR2(510,15),ROPT(15,15),RPERN(5),P(510),DV(510)
      ADD=0.0
  120 READ INPUT TAPE 2,202,TITLE1,G,RIN,RPLAN,W,VIN,N
  202 FORMAT (12A6,/5E12.0,I15)
      DELV=W*29.8
      EO=(VIN*VIN)/2.0-G/(RIN*RPLAN)
      VINF2=2.0*EO
      RPER(1)=2.0*G/VINF2
      ADD=ADD+1.0
      IF(ADD-3.0)22,33,33
   22 RPER(2)=1.1*RPLAN
      GO TO 66
   33 RPER(2)=6690.0
   66 AO=G/(2.0*EO)
      DO 70 I=1,2
      COUNT=0.0
      DVSUP=1000000.0
   21 READ INPUT TAPE 2,203,TITLE2,RINPUT
  203 FORMAT (12A6,/E12.0)
      ECCO=(RPER(I)/AO)+1.0
      BO=AO*SQRTF((ECCO*ECCO)-1.0)
      VOO=SQRTF(G*(2.0/RPER(I)+1.0/AO))
      HO=RPER(I)*VOO
      VCO=SQRTF(G/RPER(I))
      DVO=VOO-VCO
      DVON=DVO/29.8
      RPERN(I)=RPER(I)/RPLAN
      R(1)=RINPUT
      RD=RPLAN*(RIN-R(1))/500.0
      P(1)=(RPERN(I)-1.0)/(10.0*W)
      R(1)=RINPUT*RPLAN
      DO 102 L=2,501
      R(L)=R(L-1)+RD
      VO=SQRTF(G*(2.0/R(L)+1.0/AO))
      SFIO=HO/(R(L)*VO)
      FIO=ASIN(SFIO)
      VOV2=VO*VO+DELV*DELV
      VOV=SQRTF(VOV2)
      FI=FIO+ATANF(DELV/VO)
      ATRU=(G*R(L))/(R(L)*(VOV*VOV)-2.0*G)
      HTRU=R(L)*VOV*SINF(FI)
      ETRU=G/(2.0*ATRU)
      BTRU=SQRTF((HTRU*HTRU)/(2.0*ETRU))
      ECTRU=SQRTF((BTRU*BTRU)/(ATRU*ATRU)+1.0)
      ROTRU=ATRU*(ECTRU-1.)
      DELRPN=(ROTRU-RPER(I))/RPLAN
  102 P(L)=DELRPN/W
      DO 101 L=1,501
      R(L)=R(L)/RPLAN
```

```
      DDV3=P(501)/P(L)
  101 DDV(L)=DDV3*DDV3
      WRITE OUTPUT TAPE 3,301,TITLE1,TITLE2
  301 FORMAT (12A6,/12A6)
      DV(501)=0.0
      DVD=SQRTF(DDV(1))
      WRITE OUTPUT TAPE 3,305,DVD,R(1)
  305 FORMAT (1H0,9X,1H1,4X,6HDVOPT=E12.5,/15X,12HROPT( 1, 1)=E11.4)
      RR2(1,1)=R(1)
      ROPT(1,1)=R(1)
      DO 16 M=2,N
      MM=M-1
      MMM=M-2
      DVOPT=100000000.0
      FOPT2(1)=0.0
      DO 14 J=M,500
      RR1(J,1)=R(1)
      FOPT1(J)=10000000.0
      JJ=J-1
      IF(MMM)2,2,3
    2 DV3=P(J)/P(1)
      DV(1)=DV3*DV3
      FOPT1(J)=DV(1)
      FOPT1(1)=0.0
      GO TO 9
    3 DO 8 K=MM,JJ
      DV3=P(J)/P(K)
      DV(K)=DV3*DV3
      FUNC=DV(K)+FOPT2(K)
      IF(FOPT1(J)-FUNC)8,6,6
    6 FOPT1(J)=FUNC
      DO 7 L=2,MM
    7 RR1(J,L)=RR2(K,L)
    8 CONTINUE
    9 RR1(J,M)=R(J)
      TEST=FOPT1(J)+DDV(J)
      IF(DVOPT-TEST)14,14,10
   10 DVOPT=TEST
      DO 11 L=1,M
   11 ROPT(M,L)=RR1(J,L)
   14 CONTINUE
      DO 12 J=M,501
      DO 13 L=1,M
   13 RR2(J,L)=RR1(J,L)
   12 FOPT2(J)=FOPT1(J)
      DVOPT1=SQRTF(DVOPT)
      COUNT=COUNT+1.0
      IF(COUNT-8.0)43,40,41
   40 WRITE OUTPUT TAPE 3,333
      GO TO 43
   41 IF(COUNT-12.0)43,42,43
   42 WRITE OUTPUT TAPE 3,333
  333 FORMAT (1H1)
```

```
  43 WRITE OUTPUT TAPE 3,303,M,DVOPT1
 303 FORMAT (1H0,8X,I2,4X,6HDVOPT=E12.5)
     DO 15 L=1,M
  15 WRITE OUTPUT TAPE 3,304,M,L,ROPT(M,L)
 304 FORMAT (15X,5HROPT(,I2,1H,,I2,2H)=E11.4)
     IF(DVSUP-DVOPT1)16,16,1001
1001 DVSUP=DVOPT1
     NN=M
     DO 1002 L=1,M
1002 ROPTS(L)=ROPT(M,L)
  16 CONTINUE
     N1=0
     AON=AO/RPLAN
     TTT=(AO**1.5)/SQRTF(G)
     COSHFI=(1.0/ECCO)*(1.0+RIN/AON)
     COSH2=COSHFI*COSHFI
     SINHFI=SQRTF(COSH2-1.0)
     FI=LOGF(COSHFI+SQRTF(COSH2-1.0))
     TT=TTT*(ECCO*SINHFI-FI)*(1.0/60.0)
     TT1=TT
     WRITE OUTPUT TAPE 3,306
 306 FORMAT (1H2,9X,31HTIME FROM PERI-APSIS IN MINUTES)
     DT=0.0
     TT=0.0
     WRITE OUTPUT TAPE 3,307,TITLE2,NN
 307 FORMAT (12A6,/10X,I2,2X,16HCORRECTION STEPS,
    1/11X,1HN,5X,5HRANGE,11X,4HTIME,8X,10HDELTA-TIME)
     DO 17 K=1,NN
     COSHFI=(1.0/ECCO)*(1.0+ROPTS(K)/AON)
     COSH2=COSHFI*COSHFI
     SINHFI=SQRTF(COSH2-1.0)
     FI=LOGF(COSHFI+SQRTF(COSH2-1.0))
     T=TTT*(ECCO*SINHFI-FI)*(1.0/60.0)
     DT=T-TT
     TT=T
     WRITE OUTPUT TAPE 3,308,K,ROPTS(K),T,DT
 308 FORMAT (10X,I2,2X,E11.4,2(4X,E11.4))
  17 CONTINUE
     WRITE OUTPUT TAPE 3,309,N1,RIN,TT1
 309 FORMAT (10X,I2,2X,E11.4,4X,E11.4,5X,3H0.0)
  70 CONTINUE
     GO TO 120
     END(1,0,0,0,0,0,1,0,0,1,0,0,0,0,0)
```

MULTI-STEP VARIABLE REDUCTION NUMBER PROBLEM

CLASS BI--1/2,1--H MARS-OPT

```
1    DVOPT= 0.18552E 02
     ROPT( 1, 1)= 0.2078E 02

2    DVOPT= 0.60913E 01
     ROPT( 2, 1)= 0.2078E 02
     ROPT( 2, 2)= 0.7604E 02

3    DVOPT= 0.45852E 01
     ROPT( 3, 1)= 0.2078E 02
     ROPT( 3, 2)= 0.4721E 02
     ROPT( 3, 3)= 0.1229E 03

4    DVOPT= 0.41508E 01
     ROPT( 4, 1)= 0.2078E 02
     ROPT( 4, 2)= 0.3700E 02
     ROPT( 4, 3)= 0.7604E 02
     ROPT( 4, 4)= 0.1565E 03

5    DVOPT= 0.40102E 01
     ROPT( 5, 1)= 0.2078E 02
     ROPT( 5, 2)= 0.3219E 02
     ROPT( 5, 3)= 0.5682E 02
     ROPT( 5, 4)= 0.1013E 03
     ROPT( 5, 5)= 0.1806E 03

6    DVOPT= 0.39854E 01
     ROPT( 6, 1)= 0.2078E 02
     ROPT( 6, 2)= 0.2919E 02
     ROPT( 6, 3)= 0.4721E 02
     ROPT( 6, 4)= 0.7604E 02
     ROPT( 6, 5)= 0.1229E 03
     ROPT( 6, 6)= 0.1986E 03

7    DVOPT= 0.40156E 01
     ROPT( 7, 1)= 0.2078E 02
     ROPT( 7, 2)= 0.2739E 02
     ROPT( 7, 3)= 0.4120E 02
     ROPT( 7, 4)= 0.6222E 02
     ROPT( 7, 5)= 0.9406E 02
     ROPT( 7, 6)= 0.1415E 03
     ROPT( 7, 7)= 0.2130E 03

8    DVOPT= 0.40748E 01
     ROPT( 8, 1)= 0.2078E 02
     ROPT( 8, 2)= 0.2619E 02
     ROPT( 8, 3)= 0.3760E 02
     ROPT( 8, 4)= 0.5382E 02
     ROPT( 8, 5)= 0.7664E 02
     ROPT( 8, 6)= 0.1097E 03
     ROPT( 8, 7)= 0.1571E 03
     ROPT( 8, 8)= 0.2244E 03

9    DVOPT= 0.41501E 01
     ROPT( 9, 1)= 0.2078E 02
     ROPT( 9, 2)= 0.2498E 02
     ROPT( 9, 3)= 0.3399E 02
     ROPT( 9, 4)= 0.4661E 02
     ROPT( 9, 5)= 0.6403E 02
     ROPT( 9, 6)= 0.8865E 02
     ROPT( 9, 7)= 0.1223E 03
     ROPT( 9, 8)= 0.1685E 03
     ROPT( 9, 9)= 0.2328E 03

10   DVOPT= 0.42349E 01
     ROPT(10, 1)= 0.2078E 02
     ROPT(10, 2)= 0.2438E 02
     ROPT(10, 3)= 0.3219E 02
     ROPT(10, 4)= 0.4300E 02
     ROPT(10, 5)= 0.5742E 02
     ROPT(10, 6)= 0.7664E 02
     ROPT(10, 7)= 0.1019E 03
     ROPT(10, 8)= 0.1355E 03
     ROPT(10, 9)= 0.1806E 03
     ROPT(10,10)= 0.2406E 03

11   DVOPT= 0.43253E 01
     ROPT(11, 1)= 0.2078E 02
     ROPT(11, 2)= 0.2373E 02
     ROPT(11, 3)= 0.3099E 02
     ROPT(11, 4)= 0.4000E 02
     ROPT(11, 5)= 0.5201E 02
     ROPT(11, 6)= 0.6763E 02
     ROPT(11, 7)= 0.8745E 02
     ROPT(11, 8)= 0.1133E 03
     ROPT(11, 9)= 0.1469E 03
     ROPT(11,10)= 0.1908E 03
     ROPT(11,11)= 0.2472E 03

12   DVOPT= 0.44187E 01
     ROPT(12, 1)= 0.2078E 02
     ROPT(12, 2)= 0.2318E 02
     ROPT(12, 3)= 0.2919E 02
     ROPT(12, 4)= 0.3700E 02
     ROPT(12, 5)= 0.4721E 02
     ROPT(12, 6)= 0.5982E 02
     ROPT(12, 7)= 0.7604E 02
     ROPT(12, 8)= 0.9646E 02
     ROPT(12, 9)= 0.1229E 03
     ROPT(12,10)= 0.1559E 03
     ROPT(12,11)= 0.1986E 03
     ROPT(12,12)= 0.2526E 03
```

```
13     DVOPT= 0.45138E 01                15     DVOPT= 0.47056E 01
       ROPT(13, 1)= 0.2078E 02                  ROPT(15, 1)= 0.2078E 02
       ROPT(13, 2)= 0.2258E 02                  ROPT(15, 2)= 0.2198E 02
       ROPT(13, 3)= 0.2799E 02                  ROPT(15, 3)= 0.2679E 02
       ROPT(13, 4)= 0.3459E 02                  ROPT(15, 4)= 0.3219E 02
       ROPT(13, 5)= 0.4300E 02                  ROPT(15, 5)= 0.3880E 02
       ROPT(13, 6)= 0.5382E 02                  ROPT(15, 6)= 0.4721E 02
       ROPT(13, 7)= 0.6703E 02                  ROPT(15, 7)= 0.5742E 02
       ROPT(13, 8)= 0.8385E 02                  ROPT(15, 8)= 0.6943E 02
       ROPT(13, 9)= 0.1049E 03                  ROPT(15, 9)= 0.8385E 02
       ROPT(13,10)= 0.1313E 03                  ROPT(15,10)= 0.1019E 03
       ROPT(13,11)= 0.1643E 03                  ROPT(15,11)= 0.1235E 03
       ROPT(13,12)= 0.2052E 03                  ROPT(15,12)= 0.1493E 03
       ROPT(13,13)= 0.2568E 03                  ROPT(15,13)= 0.1806E 03
                                                ROPT(15,14)= 0.2190E 03
14     DVOPT= 0.46097E 01                       ROPT(15,15)= 0.2652E 03
       ROPT(14, 1)= 0.2078E 02
       ROPT(14, 2)= 0.2258E 02
       ROPT(14, 3)= 0.2739E 02
       ROPT(14, 4)= 0.3339E 02
       ROPT(14, 5)= 0.4120E 02
       ROPT(14, 6)= 0.5081E 02
       ROPT(14, 7)= 0.6222E 02
       ROPT(14, 8)= 0.7664E 02
       ROPT(14, 9)= 0.9406E 02
       ROPT(14,10)= 0.1157E 03
       ROPT(14,11)= 0.1421E 03
       ROPT(14,12)= 0.1745E 03
       ROPT(14,13)= 0.2142E 03
       ROPT(14,14)= 0.2622E 03
```

TIME FROM PERI-APSIS IN MINUTES

CLASS BI--1/2,1--H MARS-OPT

6 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
1	0.2078E 02	0.3864E 03	0.3864E 03
2	0.2919E 02	0.5573E 03	0.1709E 03
3	0.4721E 02	0.9278E 03	0.3705E 03
4	0.7604E 02	0.1528E 04	0.5999E 03
5	0.1229E 03	0.2511E 04	0.9835E 03
6	0.1986E 03	0.4110E 04	0.1598E 04
0	0.3211E 03	0.6708E 04	0.0

```
MULTI-STEP VARIABLE REDUCTION NUMBER PROBLEM

CLASS    BI--1/2,1--H     MARS-CLOSE

1      DVOPT= 0.46981E 03
       ROPT( 1, 1)= 0.1781E 01

2      DVOPT= 0.30654E 02
       ROPT( 2, 1)= 0.1781E 01
       ROPT( 2, 2)= 0.1711E 02

3      DVOPT= 0.13474E 02
       ROPT( 3, 1)= 0.1781E 01
       ROPT( 3, 2)= 0.6251E 01
       ROPT( 3, 3)= 0.4521E 02

4      DVOPT= 0.93273E 01
       ROPT( 4, 1)= 0.1781E 01
       ROPT( 4, 2)= 0.4336E 01
       ROPT( 4, 3)= 0.1775E 02
       ROPT( 4, 4)= 0.7650E 02

5      DVOPT= 0.76577E 01
       ROPT( 5, 1)= 0.1781E 01
       ROPT( 5, 2)= 0.3058E 01
       ROPT( 5, 3)= 0.9445E 01
       ROPT( 5, 4)= 0.3116E 02
       ROPT( 5, 5)= 0.1008E 03

6      DVOPT= 0.68582E 01
       ROPT( 6, 1)= 0.1781E 01
       ROPT( 6, 2)= 0.2420E 01
       ROPT( 6, 3)= 0.5613E 01
       ROPT( 6, 4)= 0.1519E 02
       ROPT( 6, 5)= 0.4265E 02
       ROPT( 6, 6)= 0.1174E 03

7      DVOPT= 0.63718E 01
       ROPT( 7, 1)= 0.1781E 01
       ROPT( 7, 2)= 0.2420E 01
       ROPT( 7, 3)= 0.4974E 01
       ROPT( 7, 4)= 0.1136E 02
       ROPT( 7, 5)= 0.2669E 02
       ROPT( 7, 6)= 0.6181E 02
       ROPT( 7, 7)= 0.1410E 03

8      DVOPT= 0.61158E 01
       ROPT( 8, 1)= 0.1781E 01
       ROPT( 8, 2)= 0.2420E 01
       ROPT( 8, 3)= 0.4336E 01
       ROPT( 8, 4)= 0.8806E 01
       ROPT( 8, 5)= 0.1839E 02
       ROPT( 8, 6)= 0.3818E 02
       ROPT( 8, 7)= 0.7842E 02
       ROPT( 8, 8)= 0.1589E 03

9      DVOPT= 0.59807E 01
       ROPT( 9, 1)= 0.1781E 01
       ROPT( 9, 2)= 0.2420E 01
       ROPT( 9, 3)= 0.4336E 01
       ROPT( 9, 4)= 0.7529E 01
       ROPT( 9, 5)= 0.1392E 02
       ROPT( 9, 6)= 0.2605E 02
       ROPT( 9, 7)= 0.4904E 02
       ROPT( 9, 8)= 0.9183E 02
       ROPT( 9, 9)= 0.1717E 03

10     DVOPT= 0.59065E 01
       ROPT(10, 1)= 0.1781E 01
       ROPT(10, 2)= 0.2420E 01
       ROPT(10, 3)= 0.3697E 01
       ROPT(10, 4)= 0.6251E 01
       ROPT(10, 5)= 0.1072E 02
       ROPT(10, 6)= 0.1902E 02
       ROPT(10, 7)= 0.3371E 02
       ROPT(10, 8)= 0.5990E 02
       ROPT(10, 9)= 0.1052E 03
       ROPT(10,10)= 0.1838E 03

11     DVOPT= 0.58782E 01
       ROPT(11, 1)= 0.1781E 01
       ROPT(11, 2)= 0.2420E 01
       ROPT(11, 3)= 0.3697E 01
       ROPT(11, 4)= 0.5613E 01
       ROPT(11, 5)= 0.9445E 01
       ROPT(11, 6)= 0.1583E 02
       ROPT(11, 7)= 0.2605E 02
       ROPT(11, 8)= 0.4329E 02
       ROPT(11, 9)= 0.7203E 02
       ROPT(11,10)= 0.1187E 03
       ROPT(11,11)= 0.1953E 03

12     DVOPT= 0.58770E 01
       ROPT(12, 1)= 0.1781E 01
       ROPT(12, 2)= 0.2420E 01
       ROPT(12, 3)= 0.3697E 01
       ROPT(12, 4)= 0.5613E 01
       ROPT(12, 5)= 0.8806E 01
       ROPT(12, 6)= 0.1392E 02
       ROPT(12, 7)= 0.2222E 02
       ROPT(12, 8)= 0.3499E 02
       ROPT(12, 9)= 0.5479E 02
       ROPT(12,10)= 0.8544E 02
       ROPT(12,11)= 0.1327E 03
       ROPT(12,12)= 0.2061E 03
```

```
13      DVOPT= 0.58987E 01
        ROPT(13, 1)= 0.1781E 01
        ROPT(13, 2)= 0.2420E 01
        ROPT(13, 3)= 0.3697E 01
        ROPT(13, 4)= 0.5613E 01
        ROPT(13, 5)= 0.8167E 01
        ROPT(13, 6)= 0.1200E 02
        ROPT(13, 7)= 0.1839E 02
        ROPT(13, 8)= 0.2797E 02
        ROPT(13, 9)= 0.4202E 02
        ROPT(13,10)= 0.6309E 02
        ROPT(13,11)= 0.9502E 02
        ROPT(13,12)= 0.1429E 03
        ROPT(13,13)= 0.2138E 03

14      DVOPT= 0.59272E 01
        ROPT(14, 1)= 0.1781E 01
        ROPT(14, 2)= 0.2420E 01
        ROPT(14, 3)= 0.3058E 01
        ROPT(14, 4)= 0.4336E 01
        ROPT(14, 5)= 0.6251E 01
        ROPT(14, 6)= 0.9445E 01
        ROPT(14, 7)= 0.1392E 02
        ROPT(14, 8)= 0.2094E 02
        ROPT(14, 9)= 0.3116E 02
        ROPT(14,10)= 0.4649E 02
        ROPT(14,11)= 0.6884E 02
        ROPT(14,12)= 0.1014E 03
        ROPT(14,13)= 0.1487E 03
        ROPT(14,14)= 0.2183E 03

15      DVOPT= 0.59659E 01
        ROPT(15, 1)= 0.1781E 01
        ROPT(15, 2)= 0.2420E 01
        ROPT(15, 3)= 0.3058E 01
        ROPT(15, 4)= 0.4336E 01
        ROPT(15, 5)= 0.6251E 01
        ROPT(15, 6)= 0.8806E 01
        ROPT(15, 7)= 0.1264E 02
        ROPT(15, 8)= 0.1839E 02
        ROPT(15, 9)= 0.2669E 02
        ROPT(15,10)= 0.3818E 02
        ROPT(15,11)= 0.5479E 02
        ROPT(15,12)= 0.7842E 02
        ROPT(15,13)= 0.1116E 03
        ROPT(15,14)= 0.1589E 03
        ROPT(15,15)= 0.2259E 03
```

TIME FROM PERI-APSIS IN MINUTES

CLASS BI--1/2,1--H MARS-CLOSE

12 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
1	0.1781E 01	0.1889E 02	0.1889E 02
2	0.2420E 01	0.2987E 02	0.1098E 02
3	0.3697E 01	0.5122E 02	0.2135E 02
4	0.5613E 01	0.8410E 02	0.3289E 02
5	0.8806E 01	0.1415E 03	0.5740E 02
6	0.1392E 02	0.2377E 03	0.9622E 02
7	0.2222E 02	0.4002E 03	0.1625E 03
8	0.3499E 02	0.6575E 03	0.2573E 03
9	0.5479E 02	0.1064E 04	0.4067E 03
10	0.8544E 02	0.1702E 04	0.6382E 03
11	0.1327E 03	0.2695E 04	0.9926E 03
12	0.2061E 03	0.4247E 04	0.1551E 04
0	0.3211E 03	0.6684E 04	0.0

MULTI-STEP VARIABLE REDUCTION NUMBER PROBLEM

CLASS EX---0,0---A VENUS-OPT

```
1   DVOPT= 0.82158E 01
    ROPT( 1, 1)= 0.2178E 02

2   DVOPT= 0.40536E 01
    ROPT( 2, 1)= 0.2178E 02
    ROPT( 2, 2)= 0.5749E 02

3   DVOPT= 0.34950E 01
    ROPT( 3, 1)= 0.2178E 02
    ROPT( 3, 2)= 0.4077E 02
    ROPT( 3, 3)= 0.8159E 02

4   DVOPT= 0.33861E 01
    ROPT( 4, 1)= 0.2178E 02
    ROPT( 4, 2)= 0.3425E 02
    ROPT( 4, 3)= 0.5778E 02
    ROPT( 4, 4)= 0.9717E 02

5   DVOPT= 0.34073E 01
    ROPT( 5, 1)= 0.2178E 02
    ROPT( 5, 2)= 0.3085E 02
    ROPT( 5, 3)= 0.4672E 02
    ROPT( 5, 4)= 0.7082E 02
    ROPT( 5, 5)= 0.1077E 03

6   DVOPT= 0.34795E 01
    ROPT( 6, 1)= 0.2178E 02
    ROPT( 6, 2)= 0.2858E 02
    ROPT( 6, 3)= 0.4049E 02
    ROPT( 6, 4)= 0.5749E 02
    ROPT( 6, 5)= 0.8159E 02
    ROPT( 6, 6)= 0.1156E 03

7   DVOPT= 0.35745E 01
    ROPT( 7, 1)= 0.2178E 02
    ROPT( 7, 2)= 0.2745E 02
    ROPT( 7, 3)= 0.3680E 02
    ROPT( 7, 4)= 0.4956E 02
    ROPT( 7, 5)= 0.6685E 02
    ROPT( 7, 6)= 0.9009E 02
    ROPT( 7, 7)= 0.1213E 03

8   DVOPT= 0.36803E 01
    ROPT( 8, 1)= 0.2178E 02
    ROPT( 8, 2)= 0.2632E 02
    ROPT( 8, 3)= 0.3425E 02
    ROPT( 8, 4)= 0.4446E 02
    ROPT( 8, 5)= 0.5778E 02
    ROPT( 8, 6)= 0.7507E 02
    ROPT( 8, 7)= 0.9717E 02
    ROPT( 8, 8)= 0.1261E 03

9   DVOPT= 0.37910E 01
    ROPT( 9, 1)= 0.2178E 02
    ROPT( 9, 2)= 0.2546E 02
    ROPT( 9, 3)= 0.3198E 02
    ROPT( 9, 4)= 0.4049E 02
    ROPT( 9, 5)= 0.5097E 02
    ROPT( 9, 6)= 0.6430E 02
    ROPT( 9, 7)= 0.8130E 02
    ROPT( 9, 8)= 0.1026E 03
    ROPT( 9, 9)= 0.1295E 03

10  DVOPT= 0.39036E 01
    ROPT(10, 1)= 0.2178E 02
    ROPT(10, 2)= 0.2490E 02
    ROPT(10, 3)= 0.3057E 02
    ROPT(10, 4)= 0.3765E 02
    ROPT(10, 5)= 0.4644E 02
    ROPT(10, 6)= 0.5721E 02
    ROPT(10, 7)= 0.7053E 02
    ROPT(10, 8)= 0.8697E 02
    ROPT(10, 9)= 0.1074E 03
    ROPT(10,10)= 0.1326E 03

11  DVOPT= 0.40165E 01
    ROPT(11, 1)= 0.2178E 02
    ROPT(11, 2)= 0.2461E 02
    ROPT(11, 3)= 0.2972E 02
    ROPT(11, 4)= 0.3595E 02
    ROPT(11, 5)= 0.4332E 02
    ROPT(11, 6)= 0.5239E 02
    ROPT(11, 7)= 0.6345E 02
    ROPT(11, 8)= 0.7677E 02
    ROPT(11, 9)= 0.9264E 02
    ROPT(11,10)= 0.1119E 03
    ROPT(11,11)= 0.1352E 03

12  DVOPT= 0.41287E 01
    ROPT(12, 1)= 0.2178E 02
    ROPT(12, 2)= 0.2405E 02
    ROPT(12, 3)= 0.2858E 02
    ROPT(12, 4)= 0.3397E 02
    ROPT(12, 5)= 0.4049E 02
    ROPT(12, 6)= 0.4814E 02
    ROPT(12, 7)= 0.5721E 02
    ROPT(12, 8)= 0.6826E 02
    ROPT(12, 9)= 0.8130E 02
    ROPT(12,10)= 0.9689E 02
    ROPT(12,11)= 0.1153E 03
    ROPT(12,12)= 0.1374E 03
```

```
13     DVOPT= 0.42397E 01
       ROPT(13, 1)= 0.2178E 02
       ROPT(13, 2)= 0.2376E 02
       ROPT(13, 3)= 0.2802E 02
       ROPT(13, 4)= 0.3283E 02
       ROPT(13, 5)= 0.3850E 02
       ROPT(13, 6)= 0.4531E 02
       ROPT(13, 7)= 0.5324E 02
       ROPT(13, 8)= 0.6260E 02
       ROPT(13, 9)= 0.7337E 02
       ROPT(13,10)= 0.8612E 02
       ROPT(13,11)= 0.1011E 03
       ROPT(13,12)= 0.1187E 03
       ROPT(13,13)= 0.1394E 03

14     DVOPT= 0.43491E 01
       ROPT(14, 1)= 0.2178E 02
       ROPT(14, 2)= 0.2348E 02
       ROPT(14, 3)= 0.2717E 02
       ROPT(14, 4)= 0.3142E 02
       ROPT(14, 5)= 0.3652E 02
       ROPT(14, 6)= 0.4247E 02
       ROPT(14, 7)= 0.4927E 02
       ROPT(14, 8)= 0.5721E 02
       ROPT(14, 9)= 0.6656E 02
       ROPT(14,10)= 0.7733E 02
       ROPT(14,11)= 0.8981E 02
       ROPT(14,12)= 0.1043E 03
       ROPT(14,13)= 0.1213E 03
       ROPT(14,14)= 0.1408E 03

15     DVOPT= 0.44568E 01
       ROPT(15, 1)= 0.2178E 02
       ROPT(15, 2)= 0.2348E 02
       ROPT(15, 3)= 0.2688E 02
       ROPT(15, 4)= 0.3085E 02
       ROPT(15, 5)= 0.3539E 02
       ROPT(15, 6)= 0.4077E 02
       ROPT(15, 7)= 0.4672E 02
       ROPT(15, 8)= 0.5381E 02
       ROPT(15, 9)= 0.6174E 02
       ROPT(15,10)= 0.7110E 02
       ROPT(15,11)= 0.8159E 02
       ROPT(15,12)= 0.9377E 02
       ROPT(15,13)= 0.1077E 03
       ROPT(15,14)= 0.1238E 03
       ROPT(15,15)= 0.1422E 03
```

```
TIME FROM PERI-APSIS IN MINUTES

CLASS   EX---0,0---A       VENUS-OPT
  4  CORRECTION STEPS
  N      RANGE           TIME           DELTA-TIME
  1   0.2178E 02      0.2905E 03      0.2905E 03
  2   0.3425E 02      0.4679E 03      0.1774E 03
  3   0.5778E 02      0.8061E 03      0.3382E 03
  4   0.9717E 02      0.1377E 04      0.5709E 03
  0   0.1635E 03      0.2343E 04      0.0
```

MULTI-STEP VARIABLE REDUCTION NUMBER PRCBLEM

CLASS EX---0,0---A VENUS-CLOSE

```
1   DVOPT= 0.89037E 02
    ROPT( 1, 1)= 0.2925E 01

2   DVOPT= 0.13345E 02
    ROPT( 2, 1)= 0.2925E 01
    ROPT( 2, 2)= 0.1802E 02

3   DVOPT= 0.77343E 01
    ROPT( 3, 1)= 0.2925E 01
    ROPT( 3, 2)= 0.8706E 01
    ROPT( 3, 3)= 0.3793E 02

4   DVOPT= 0.61438E 01
    ROPT( 4, 1)= 0.2925E 01
    ROPT( 4, 2)= 0.6136E 01
    ROPT( 4, 3)= 0.1802E 02
    ROPT( 4, 4)= 0.5463E 02

5   DVOPT= 0.54889E 01
    ROPT( 5, 1)= 0.2925E 01
    ROPT( 5, 2)= 0.4852E 01
    ROPT( 5, 3)= 0.1160E 02
    ROPT( 5, 4)= 0.2797E 02
    ROPT( 5, 5)= 0.6780E 02

6   DVOPT= 0.51775E 01
    ROPT( 6, 1)= 0.2925E 01
    ROPT( 6, 2)= 0.4210E 01
    ROPT( 6, 3)= 0.8385E 01
    ROPT( 6, 4)= 0.1770E 02
    ROPT( 6, 5)= 0.3729E 02
    ROPT( 6, 6)= 0.7840E 02

7   DVOPT= 0.50245E 01
    ROPT( 7, 1)= 0.2925E 01
    ROPT( 7, 2)= 0.3888E 01
    ROPT( 7, 3)= 0.7100E 01
    ROPT( 7, 4)= 0.1320E 02
    ROPT( 7, 5)= 0.2476E 02
    ROPT( 7, 6)= 0.4660E 02
    ROPT( 7, 7)= 0.8739E 02

8   DVOPT= 0.49585E 01
    ROPT( 8, 1)= 0.2925E 01
    ROPT( 8, 2)= 0.3567E 01
    ROPT( 8, 3)= 0.5815E 01
    ROPT( 8, 4)= 0.9990E 01
    ROPT( 8, 5)= 0.1738E 02
    ROPT( 8, 6)= 0.3054E 02
    ROPT( 8, 7)= 0.5367E 02
    ROPT( 8, 8)= 0.9381E 02

9   DVOPT= 0.49407E 01
    ROPT( 9, 1)= 0.2925E 01
    ROPT( 9, 2)= 0.3567E 01
    ROPT( 9, 3)= 0.5494E 01
    ROPT( 9, 4)= 0.8706E 01
    ROPT( 9, 5)= 0.1417E 02
    ROPT( 9, 6)= 0.2316E 02
    ROPT( 9, 7)= 0.3793E 02
    ROPT( 9, 8)= 0.6202E 02
    ROPT( 9, 9)= 0.1009E 03

10  DVOPT= 0.49549E 01
    ROPT(10, 1)= 0.2925E 01
    ROPT(10, 2)= 0.3246E 01
    ROPT(10, 3)= 0.4852E 01
    ROPT(10, 4)= 0.7421E 01
    ROPT(10, 5)= 0.1160E 02
    ROPT(10, 6)= 0.1802E 02
    ROPT(10, 7)= 0.2797E 02
    ROPT(10, 8)= 0.4371E 02
    ROPT(10, 9)= 0.6812E 02
    ROPT(10,10)= 0.1057E 03

11  DVOPT= 0.49887E 01
    ROPT(11, 1)= 0.2925E 01
    ROPT(11, 2)= 0.3246E 01
    ROPT(11, 3)= 0.4531E 01
    ROPT(11, 4)= 0.6779E 01
    ROPT(11, 5)= 0.9990E 01
    ROPT(11, 6)= 0.1481E 02
    ROPT(11, 7)= 0.2219E 02
    ROPT(11, 8)= 0.3311E 02
    ROPT(11, 9)= 0.4949E 02
    ROPT(11,10)= 0.7390E 02
    ROPT(11,11)= 0.1102E 03

12  DVOPT= 0.50367E 01
    ROPT(12, 1)= 0.2925E 01
    ROPT(12, 2)= 0.3246E 01
    ROPT(12, 3)= 0.4531E 01
    ROPT(12, 4)= 0.6458E 01
    ROPT(12, 5)= 0.9027E 01
    ROPT(12, 6)= 0.1288E 02
    ROPT(12, 7)= 0.1866E 02
    ROPT(12, 8)= 0.2701E 02
    ROPT(12, 9)= 0.3889E 02
    ROPT(12,10)= 0.5591E 02
    ROPT(12,11)= 0.8000E 02
    ROPT(12,12)= 0.1144E 03
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```
13    DVOPT= 0.50953E 01
      ROPT(13, 1)= 0.2925E 01
      ROPT(13, 2)= 0.3246E 01
      ROPT(13, 3)= 0.4210E 01
      ROPT(13, 4)= 0.5815E 01
      ROPT(13, 5)= 0.8063E 01
      ROPT(13, 6)= 0.1127E 02
      ROPT(13, 7)= 0.1577E 02
      ROPT(13, 8)= 0.2219E 02
      ROPT(13, 9)= 0.3087E 02
      ROPT(13,10)= 0.4307E 02
      ROPT(13,11)= 0.6009E 02
      ROPT(13,12)= 0.8385E 02
      ROPT(13,13)= 0.1173E 03

14    DVOPT= 0.51599E 01
      ROPT(14, 1)= 0.2925E 01
      ROPT(14, 2)= 0.3246E 01
      ROPT(14, 3)= 0.4210E 01
      ROPT(14, 4)= 0.5494E 01
      ROPT(14, 5)= 0.7421E 01
      ROPT(14, 6)= 0.9990E 01
      ROPT(14, 7)= 0.1352E 02
      ROPT(14, 8)= 0.1834E 02
      ROPT(14, 9)= 0.2508E 02
      ROPT(14,10)= 0.3440E 02
      ROPT(14,11)= 0.4692E 02
      ROPT(14,12)= 0.6426E 02
      ROPT(14,13)= 0.8771E 02
      ROPT(14,14)= 0.1198E 03

15    DVOPT= 0.52295E 01
      ROPT(15, 1)= 0.2925E 01
      ROPT(15, 2)= 0.3246E 01
      ROPT(15, 3)= 0.4210E 01
      ROPT(15, 4)= 0.5494E 01
      ROPT(15, 5)= 0.7100E 01
      ROPT(15, 6)= 0.9348E 01
      ROPT(15, 7)= 0.1256E 02
      ROPT(15, 8)= 0.1673E 02
      ROPT(15, 9)= 0.2219E 02
      ROPT(15,10)= 0.2958E 02
      ROPT(15,11)= 0.3954E 02
      ROPT(15,12)= 0.5270E 02
      ROPT(15,13)= 0.7005E 02
      ROPT(15,14)= 0.9285E 02
      ROPT(15,15)= 0.1234E 03
```

TIME FROM PERI-APSIS IN MINUTES

CLASS EX---0,0---A VENUS-CLOSE

9 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
1	0.2925E 01	0.3008E 02	0.3008E 02
2	0.3567E 01	0.3829E 02	0.8209E 01
3	0.5494E 01	0.6313E 02	0.2484E 02
4	0.8706E 01	0.1056E 03	0.4248E 02
5	0.1417E 02	0.1800E 03	0.7437E 02
6	0.2316E 02	0.3055E 03	0.1255E 03
7	0.3793E 02	0.5155E 03	0.2099E 03
8	0.6202E 02	0.8619E 03	0.3464E 03
9	0.1009E 03	0.1425E 04	0.5632E 03
0	0.1635E 03	0.2337E 04	0.0

```
MULTI-STEP VARIABLE REDUCTION NUMBER PROBLEM

CLASS  IN---0,0---A     MARS-OPT-RETURN

1     DVOPT= 0.19991E 02
      ROPT( 1, 1)= 0.1319E 02

2     DVOPT= 0.63232E 01
      ROPT( 2, 1)= 0.1319E 02
      ROPT( 2, 2)= 0.5306E 02

3     DVOPT= 0.47009E 01
      ROPT( 3, 1)= 0.1319E 02
      ROPT( 3, 2)= 0.3224E 02
      ROPT( 3, 3)= 0.8717E 02

4     DVOPT= 0.42291E 01
      ROPT( 4, 1)= 0.1319E 02
      ROPT( 4, 2)= 0.2515E 02
      ROPT( 4, 3)= 0.5306E 02
      ROPT( 4, 4)= 0.1115E 03

5     DVOPT= 0.40706E 01
      ROPT( 5, 1)= 0.1319E 02
      ROPT( 5, 2)= 0.2205E 02
      ROPT( 5, 3)= 0.3977E 02
      ROPT( 5, 4)= 0.7211E 02
      ROPT( 5, 5)= 0.1301E 03

6     DVOPT= 0.40354E 01
      ROPT( 6, 1)= 0.1319E 02
      ROPT( 6, 2)= 0.1984E 02
      ROPT( 6, 3)= 0.3268E 02
      ROPT( 6, 4)= 0.5350E 02
      ROPT( 6, 5)= 0.8762E 02
      ROPT( 6, 6)= 0.1434E 03

7     DVOPT= 0.40587E 01
      ROPT( 7, 1)= 0.1319E 02
      ROPT( 7, 2)= 0.1851E 02
      ROPT( 7, 3)= 0.2825E 02
      ROPT( 7, 4)= 0.4332E 02
      ROPT( 7, 5)= 0.6635E 02
      ROPT( 7, 6)= 0.1014E 03
      ROPT( 7, 7)= 0.1545E 03

8     DVOPT= 0.41130E 01
      ROPT( 8, 1)= 0.1319E 02
      ROPT( 8, 2)= 0.1762E 02
      ROPT( 8, 3)= 0.2559E 02
      ROPT( 8, 4)= 0.3711E 02
      ROPT( 8, 5)= 0.5350E 02
      ROPT( 8, 6)= 0.7743E 02
      ROPT( 8, 7)= 0.1120E 03
      ROPT( 8, 8)= 0.1620E 03

9     DVOPT= 0.41847E 01
      ROPT( 9, 1)= 0.1319E 02
      ROPT( 9, 2)= 0.1673E 02
      ROPT( 9, 3)= 0.2338E 02
      ROPT( 9, 4)= 0.3268E 02
      ROPT( 9, 5)= 0.4553E 02
      ROPT( 9, 6)= 0.6325E 02
      ROPT( 9, 7)= 0.8762E 02
      ROPT( 9, 8)= 0.1217E 03
      ROPT( 9, 9)= 0.1691E 03

10    DVOPT= 0.42666E 01
      ROPT(10, 1)= 0.1319E 02
      ROPT(10, 2)= 0.1629E 02
      ROPT(10, 3)= 0.2205E 02
      ROPT(10, 4)= 0.2958E 02
      ROPT(10, 5)= 0.3977E 02
      ROPT(10, 6)= 0.5350E 02
      ROPT(10, 7)= 0.7211E 02
      ROPT(10, 8)= 0.9692E 02
      ROPT(10, 9)= 0.1301E 03
      ROPT(10,10)= 0.1749E 03

11    DVOPT= 0.43547E 01
      ROPT(11, 1)= 0.1319E 02
      ROPT(11, 2)= 0.1585E 02
      ROPT(11, 3)= 0.2072E 02
      ROPT(11, 4)= 0.2692E 02
      ROPT(11, 5)= 0.3534E 02
      ROPT(11, 6)= 0.4642E 02
      ROPT(11, 7)= 0.6104E 02
      ROPT(11, 8)= 0.8009E 02
      ROPT(11, 9)= 0.1049E 03
      ROPT(11,10)= 0.1372E 03
      ROPT(11,11)= 0.1793E 03

12    DVOPT= 0.44463E 01
      ROPT(12, 1)= 0.1319E 02
      ROPT(12, 2)= 0.1541E 02
      ROPT(12, 3)= 0.1984E 02
      ROPT(12, 4)= 0.2559E 02
      ROPT(12, 5)= 0.3268E 02
      ROPT(12, 6)= 0.4199E 02
      ROPT(12, 7)= 0.5350E 02
      ROPT(12, 8)= 0.6857E 02
      ROPT(12, 9)= 0.8762E 02
      ROPT(12,10)= 0.1120E 03
      ROPT(12,11)= 0.1434E 03
      ROPT(12,12)= 0.1833E 03
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13     DVOPT= 0.45399E 01
       ROPT(13, 1)= 0.1319E 02
       ROPT(13, 2)= 0.1541E 02
       ROPT(13, 3)= 0.1939E 02
       ROPT(13, 4)= 0.2427E 02
       ROPT(13, 5)= 0.3047E 02
       ROPT(13, 6)= 0.3844E 02
       ROPT(13, 7)= 0.4819E 02
       ROPT(13, 8)= 0.6059E 02
       ROPT(13, 9)= 0.7610E 02
       ROPT(13,10)= 0.9559E 02
       ROPT(13,11)= 0.1195E 03
       ROPT(13,12)= 0.1496E 03
       ROPT(13,13)= 0.1873E 03

14     DVOPT= 0.46343E 01
       ROPT(14, 1)= 0.1319E 02
       ROPT(14, 2)= 0.1496E 02
       ROPT(14, 3)= 0.1851E 02
       ROPT(14, 4)= 0.2294E 02
       ROPT(14, 5)= 0.2825E 02
       ROPT(14, 6)= 0.3490E 02
       ROPT(14, 7)= 0.4332E 02
       ROPT(14, 8)= 0.5350E 02
       ROPT(14, 9)= 0.6591E 02
       ROPT(14,10)= 0.8142E 02
       ROPT(14,11)= 0.1005E 03
       ROPT(14,12)= 0.1244E 03
       ROPT(14,13)= 0.1536E 03
       ROPT(14,14)= 0.1900E 03

15     DVOPT= 0.47291E 01
       ROPT(15, 1)= 0.1319E 02
       ROPT(15, 2)= 0.1452E 02
       ROPT(15, 3)= 0.1762E 02
       ROPT(15, 4)= 0.2161E 02
       ROPT(15, 5)= 0.2648E 02
       ROPT(15, 6)= 0.3224E 02
       ROPT(15, 7)= 0.3933E 02
       ROPT(15, 8)= 0.4819E 02
       ROPT(15, 9)= 0.5882E 02
       ROPT(15,10)= 0.7167E 02
       ROPT(15,11)= 0.8717E 02
       ROPT(15,12)= 0.1062E 03
       ROPT(15,13)= 0.1297E 03
       ROPT(15,14)= 0.1581E 03
       ROPT(15,15)= 0.1926E 03
```

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0.0---A MARS-OPT-RETURN

6 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
1	0.1319E 02	0.1388E 03	0.1388E 03
2	0.1984E 02	0.2138E 03	0.7499E 02
3	0.3268E 02	0.3604E 03	0.1466E 03
4	0.5350E 02	0.6002E 03	0.2397E 03
5	0.8762E 02	0.9953E 03	0.3951E 03
6	0.1434E 03	0.1644E 04	0.6491E 03
0	0.2347E 03	0.2708E 04	0.0

```
MULTI-STEP VARIABLE REDUCTION NUMBER PRCBLEM

CLASS   IN---0,0---A      MARS-CLOSE-RETURN

1       DVOPT= 0.20375E 03
        ROPT( 1, 1)= 0.2197E 01

2       DVOPT= 0.20187E 02
        ROPT( 2, 1)= 0.2197E 01
        ROPT( 2, 2)= 0.1708E 02

3       DVOPT= 0.10194E 02
        ROPT( 3, 1)= 0.2197E 01
        ROPT( 3, 2)= 0.7312E 01
        ROPT( 3, 3)= 0.4126E 02

4       DVOPT= 0.75625E 01
        ROPT( 4, 1)= 0.2197E 01
        ROPT( 4, 2)= 0.4522E 01
        ROPT( 4, 3)= 0.1661E 02
        ROPT( 4, 4)= 0.6265E 02

5       DVOPT= 0.64795E 01
        ROPT( 5, 1)= 0.2197E 01
        ROPT( 5, 2)= 0.3592E 01
        ROPT( 5, 3)= 0.9637E 01
        ROPT( 5, 4)= 0.2777E 02
        ROPT( 5, 5)= 0.8125E 02

6       DVOPT= 0.59439E 01
        ROPT( 6, 1)= 0.2197E 01
        ROPT( 6, 2)= 0.3127E 01
        ROPT( 6, 3)= 0.6847E 01
        ROPT( 6, 4)= 0.1661E 02
        ROPT( 6, 5)= 0.4033E 02
        ROPT( 6, 6)= 0.9752E 02

7       DVOPT= 0.56655E 01
        ROPT( 7, 1)= 0.2197E 01
        ROPT( 7, 2)= 0.2662E 01
        ROPT( 7, 3)= 0.5452E 01
        ROPT( 7, 4)= 0.1150E 02
        ROPT( 7, 5)= 0.2452E 02
        ROPT( 7, 6)= 0.5242E 02
        ROPT( 7, 7)= 0.1110E 03

8       DVOPT= 0.54999E 01
        ROPT( 8, 1)= 0.2197E 01
        ROPT( 8, 2)= 0.2662E 01
        ROPT( 8, 3)= 0.4522E 01
        ROPT( 8, 4)= 0.8707E 01
        ROPT( 8, 5)= 0.1661E 02
        ROPT( 8, 6)= 0.3242E 02
        ROPT( 8, 7)= 0.6311E 02
        ROPT( 8, 8)= 0.1217E 03

9       DVOPT= 0.54207E 01
        ROPT( 9, 1)= 0.2197E 01
        ROPT( 9, 2)= 0.2662E 01
        ROPT( 9, 3)= 0.4522E 01
        ROPT( 9, 4)= 0.7777E 01
        ROPT( 9, 5)= 0.1382E 02
        ROPT( 9, 6)= 0.2452E 02
        ROPT( 9, 7)= 0.4312E 02
        ROPT( 9, 8)= 0.7613E 02
        ROPT( 9, 9)= 0.1338E 03

10      DVOPT= 0.53934E 01
        ROPT(10, 1)= 0.2197E 01
        ROPT(10, 2)= 0.2662E 01
        ROPT(10, 3)= 0.4057E 01
        ROPT(10, 4)= 0.6382E 01
        ROPT(10, 5)= 0.1057E 02
        ROPT(10, 6)= 0.1754E 02
        ROPT(10, 7)= 0.2963E 02
        ROPT(10, 8)= 0.4963E 02
        ROPT(10, 9)= 0.8357E 02
        ROPT(10,10)= 0.1403E 03

11      DVOPT= 0.53982E 01
        ROPT(11, 1)= 0.2197E 01
        ROPT(11, 2)= 0.2662E 01
        ROPT(11, 3)= 0.4057E 01
        ROPT(11, 4)= 0.6382E 01
        ROPT(11, 5)= 0.1010E 02
        ROPT(11, 6)= 0.1568E 02
        ROPT(11, 7)= 0.2452E 02
        ROPT(11, 8)= 0.3847E 02
        ROPT(11, 9)= 0.6079E 02
        ROPT(11,10)= 0.9566E 02
        ROPT(11,11)= 0.1501E 03

12      DVOPT= 0.54246E 01
        ROPT(12, 1)= 0.2197E 01
        ROPT(12, 2)= 0.2662E 01
        ROPT(12, 3)= 0.3592E 01
        ROPT(12, 4)= 0.5452E 01
        ROPT(12, 5)= 0.8242E 01
        ROPT(12, 6)= 0.1243E 02
        ROPT(12, 7)= 0.1894E 02
        ROPT(12, 8)= 0.2870E 02
        ROPT(12, 9)= 0.4358E 02
        ROPT(12,10)= 0.6637E 02
        ROPT(12,11)= 0.1012E 03
        ROPT(12,12)= 0.1543E 03
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13    DVOPT= 0.54622E 01
      ROPT(13, 1)= 0.2197E 01
      ROPT(13, 2)= 0.2662E 01
      ROPT(13, 3)= 0.3592E 01
      ROPT(13, 4)= 0.4987E 01
      ROPT(13, 5)= 0.7312E 01
      ROPT(13, 6)= 0.1057E 02
      ROPT(13, 7)= 0.1568E 02
      ROPT(13, 8)= 0.2312E 02
      ROPT(13, 9)= 0.3428E 02
      ROPT(13,10)= 0.5056E 02
      ROPT(13,11)= 0.7427E 02
      ROPT(13,12)= 0.1091E 03
      ROPT(13,13)= 0.1603E 03

14    DVOPT= 0.55105E 01
      ROPT(14, 1)= 0.2197E 01
      ROPT(14, 2)= 0.2662E 01
      ROPT(14, 3)= 0.3592E 01
      ROPT(14, 4)= 0.4987E 01
      ROPT(14, 5)= 0.6847E 01
      ROPT(14, 6)= 0.9637E 01
      ROPT(14, 7)= 0.1382E 02
      ROPT(14, 8)= 0.1987E 02
      ROPT(14, 9)= 0.2824E 02
      ROPT(14,10)= 0.4033E 02
      ROPT(14,11)= 0.5753E 02
      ROPT(14,12)= 0.8171E 02
      ROPT(14,13)= 0.1161E 03
      ROPT(14,14)= 0.1649E 03

15    DVOPT= 0.55671E 01
      ROPT(15, 1)= 0.2197E 01
      ROPT(15, 2)= 0.2662E 01
      ROPT(15, 3)= 0.3592E 01
      ROPT(15, 4)= 0.4987E 01
      ROPT(15, 5)= 0.6847E 01
      ROPT(15, 6)= 0.9637E 01
      ROPT(15, 7)= 0.1336E 02
      ROPT(15, 8)= 0.1847E 02
      ROPT(15, 9)= 0.2545E 02
      ROPT(15,10)= 0.3521E 02
      ROPT(15,11)= 0.4823E 02
      ROPT(15,12)= 0.6637E 02
      ROPT(15,13)= 0.9101E 02
      ROPT(15,14)= 0.1250E 03
      ROPT(15,15)= 0.1715E 03
```

TIME FROM PERI-APSIS IN MINUTES

CLASS IN---0.0---A MARS-CLOSE-RETURN

10 CORRECTION STEPS

N	RANGE	TIME	DELTA-TIME
1	0.2197E 01	0.1781E 02	0.1781E 02
2	0.2662E 01	0.2285E 02	0.5039E 01
3	0.4057E 01	0.3770E 02	0.1485E 02
4	0.6382E 01	0.6262E 02	0.2492E 02
5	0.1057E 02	0.1084E 03	0.4581E 02
6	0.1754E 02	0.1864E 03	0.7798E 02
7	0.2963E 02	0.3238E 03	0.1374E 03
8	0.4963E 02	0.5536E 03	0.2298E 03
9	0.8357E 02	0.9465E 03	0.3929E 03
10	0.1403E 03	0.1606E 04	0.6595E 03
0	0.2347E 03	0.2706E 04	0.0

Program 4

(Outbound Error Analysis)

```
GRH OUTBOUND ERROR ANALYSIS
      DIMENSION PI(20),RPER(5),TITLE(12)
      DO 1 J=1,16
      READ INPUT TAPE 2,200,PI(J)
  200 FORMAT (E10.0)
    1 PI(J)=0.0174533*PI(J)
      COUNT=0.0
  120 READ INPUT TAPE 2,201,G,RIN,RPLAN,W
  201 FORMAT (4E10.0)
      DUAL=0.0
      DELV=W*29.8
  110 READ INPUT TAPE 2,222,VIN
  222 FORMAT (E10.0)
      EO=(VIN*VIN)/2.0-G/RIN
      VINF2=2.0*EO
      RPER(1)=2.0*G/VINF2
      COUNT=COUNT+1.0
      IF(COUNT-8.0)2,2,3
    2 RPER(2)=1.1*RPLAN
      GO TO 4
    3 RPER(2)=6690.0
    4 AO=G/(2.0*EO)
      DO 70 I=1,2
      READ INPUT TAPE 2,202,TITLE
  202 FORMAT (12A6)
      ECCO=(RPER(I)/AO)+1.0
      BO=AO*SQRTF((ECCO*ECCO)-1.0)
      VOPER=SQRTF(G*(2.0/RPER(I)+1.0/AO))
      HO=VOPER*RPER(I)
      SBETAO=HO/(RIN*VIN)
      BETAO=ASIN(SBETAO)
      CTHETA=((((HO*HO)/G)/RIN)-1.0)/ECCO
      STHETA=SQRTF(1.0-(CTHETA*CTHETA))
      THETAO=ASIN(STHETA)
      IF(CTHETA)20,21,22
   20 THETAO=3.14159265-THETAO
      GO TO 22
   21 THETAO=1.57079633
   22 FIO=1.57079633
      WRITE OUTPUT TAPE 3,301,TITLE
  301 FORMAT (1H2,9X,23HOUTBOUND ERROR ANALYSIS,/12A6,
     1/13X,5HVOL/W,11X,5HVOC/W,11X,5HDELRL,11X,5HDELRC)
      DO 5 J=1,16
      VOL=DELV*COSF(PI(J))
      VOC=DELV*SINF(PI(J))
      VVV=VOPER+VOL
      FI=FIO+ATANF(VOC/VVV)
      VOV=SQRTF(VVV*VVV+VOC*VOC)
      ATRU=(G*RPER(I))/(RPER(I)*(VOV*VOV)-2.0*G)
      HTRU=RPER(I)*VOV*SINF(FI)
      ETRU=G/(2.0*ATRU)
      BTRU=SQRTF((HTRU*HTRU)/(2.0*ETRU))
     _ECTRU=SQRTF((BTRU*BTRU)/(ATRU*ATRU)+1.0)
```

```
      V=SQRTF(G*(2.0/RIN+1.0/ATRU))
      SBETA=HTRU/(RIN*V)
      BETA=ASIN(SBETA)
      DBETA=BETAO-BETA
      COMEGA=((((HTRU*HTRU)/G)/RPER(I))-1.0)/ECTRU
      CTHETA=((((HTRU*HTRU)/G)/RIN)-1.0)/ECTRU
      SOMEGA=SQRTF(1.0-(COMEGA*COMEGA))
      STHETA=SQRTF(1.0-(CTHETA*CTHETA))
      OMEGA=ASIN(SOMEGA)
      THETA=ASIN(STHETA)
      IF(CTHETA)11,12,13
   11 THETA=3.14159265-THETA
      GO TO 13
   12 THETA=1.57079633
   13 IF(VOC)6,7,8
    6 DTHETA=THETAO-OMEGA-THETA
      ANGLE=DBETA+DTHETA
      GO TO 9
    7 DTHETA=THETAO-THETA
      ANGLE=DBETA+DTHETA
      GO TO 9
    8 DTHETA=THETAO+OMEGA-THETA
      ANGLE=DBETA+DTHETA
    9 VOLL=V*COSF(ANGLE)-VIN
      VOCC=V*SINF(ANGLE)
      DELRL=(RIN*(COSF(DTHETA)-1.0))/RPLAN
      DELRC=(RIN*SINF(DTHETA))/RPLAN
      VOCCN=VOCC/DELV
      VOLLN=VOLL/DELV
    5 WRITE OUTPUT TAPE 3,302,VOLLN,VOCCN,DELRL,DELRC
  302 FORMAT (10X,E11.4,3(5X,E11.4))
   70 CONTINUE
      DUAL=DUAL+1.0
      IF(DUAL-4.0)110,120,120
      END(1,0,0,0,0,0,1,0,0,1,0,0,0,0,0)
```

OUTBOUND ERROR ANALYSIS

CLASS BI--1/2,1--H VENUS-OPT-RETURN

VOL/W	VOC/W	DELRL	DELRC
0.1344E 01	0.6834E 00	-0.6664E-02	0.1476E 01
0.1161E 01	0.1087E 01	-0.1891E-01	0.2486E 01
0.9473E 00	0.1183E 01	-0.2327E-01	0.2758E 01
0.6701E 00	0.1199E 01	-0.2478E-01	0.2846E 01
0.1802E-03	0.9878E 00	-0.1831E-01	0.2447E 01
-0.6746E 00	0.5098E 00	-0.5759E-02	0.1372E 01
-0.9568E 00	0.2032E-00	-0.1345E-02	0.6628E 00
-0.1175E 01	-0.1052E-00	-0.2923E-04	-0.9668E-01
-0.1364E 01	-0.7085E 00	-0.7803E-02	-0.1597E 01
-0.1184E 01	-0.1089E 01	-0.2038E-01	-0.2581E 01
-0.9672E 00	-0.1182E 01	-0.2463E-01	-0.2838E 01
-0.6836E 00	-0.1195E 01	-0.2570E-01	-0.2898E 01
0.2610E-03	-0.9825E 00	-0.1819E-01	-0.2438E 01
0.6789E 00	-0.5095E 00	-0.5541E-02	-0.1346E 01
0.9574E 00	-0.2123E-00	-0.1301E-02	-0.6519E 00
0.1169E 01	0.9921E-01	-0.2070E-04	0.8047E-01

OUTBOUND ERROR ANALYSIS

CLASS BI--1/2,1--H VENUS-CLOSE-RETURN

VOL/W	VOC/W	DELRL	DELRC
0.3545E 01	0.1846E 01	-0.5270E-01	0.4150E 01
0.3078E 01	0.1863E 01	-0.5512E-01	0.4245E 01
0.2525E 01	0.1675E 01	-0.4558E-01	0.3860E 01
0.1798E 01	0.1372E 01	-0.3155E-01	0.3211E 01
0.5531E-02	0.5160E 00	-0.5003E-02	0.1279E 01
-0.1849E 01	-0.4633E-00	-0.3532E-02	-0.1074E 01
-0.2639E 01	-0.9138E 00	-0.1487E-01	-0.2205E 01
-0.3254E 01	-0.1298E 01	-0.3119E-01	-0.3193E 01
-0.3785E 01	-0.1810E 01	-0.6289E-01	-0.4534E 01
-0.3266E 01	-0.1793E 01	-0.6146E-01	-0.4482E 01
-0.2653E 01	-0.1617E 01	-0.4944E-01	-0.4020E 01
-0.1862E 01	-0.1331E 01	-0.3305E-01	-0.3287E 01
0.5593E-02	-0.5086E 00	-0.4867E-02	-0.1261E 01
0.1810E 01	0.4648E-00	-0.3196E-02	0.1022E 01
0.2539E 01	0.9279E 00	-0.1320E-01	0.2077E 01
0.3090E 01	0.1329E 01	-0.2717E-01	0.2980E 01

OUTBOUND ERROR ANALYSIS

CLASS EX---0,0---A VENUS-OPT-RETURN

VOL/W	VOC/W	DELRL	DELRC
0.1401E 01	0.6698E 00	-0.1230E-02	0.6339E 00
0.1212E 01	0.1058E 01	-0.3130E-02	0.1011E 01
0.9896E 00	0.1149E 01	-0.3716E-02	0.1102E 01
0.7000E 00	0.1159E 01	-0.3816E-02	0.1117E 01
0.2738E-03	0.9507E 00	-0.2617E-02	0.9248E 00
-0.7017E 00	0.4877E-00	-0.7137E-03	0.4826E-00
-0.9936E 00	0.1969E-00	-0.1254E-03	0.2016E-00
-0.1218E 01	-0.1057E-00	-0.2679E-04	-0.9271E-01
-0.1409E 01	-0.7071E 00	-0.1420E-02	-0.6811E 00
-0.1222E 01	-0.1057E 01	-0.3216E-02	-0.1025E 01
-0.9974E 00	-0.1146E 01	-0.3785E-02	-0.1112E 01
-0.7050E 00	-0.1157E 01	-0.3867E-02	-0.1124E 01
0.2894E-03	-0.9488E 00	-0.2607E-02	-0.9231E 00
0.7033E 00	-0.4875E-00	-0.7015E-03	-0.4785E-00
0.9934E 00	-0.1990E-00	-0.1242E-03	-0.2012E-00
0.1215E 01	0.1026E-00	-0.2436E-04	0.8841E-01

OUTBOUND ERROR ANALYSIS

CLASS EX---0,0---A VENUS-CLOSE-RETURN

VOL/W	VOC/W	DELRL	DELRC
0.1696E 01	0.9921E 00	-0.2722E-02	0.9431E 00
0.1468E 01	0.1301E 01	-0.4736E-02	0.1244E 01
0.1199E 01	0.1324E 01	-0.4937E-02	0.1270E 01
0.8486E 00	0.1259E 01	-0.4496E-02	0.1212E 01
0.6653E-03	0.8780E 00	-0.2232E-02	0.8541E 00
-0.8519E 00	0.2645E-00	-0.2156E-03	0.2649E-00
-0.1207E 01	-0.8146E-01	-0.1583E-04	-0.7091E-01
-0.1481E 01	-0.4194E-00	-0.4920E-03	-0.4007E-00
-0.1714E 01	-0.1042E 01	-0.3131E-02	-0.1012E 01
-0.1485E 01	-0.1298E 01	-0.4881E-02	-0.1263E 01
-0.1212E 01	-0.1321E 01	-0.5054E-02	-0.1285E 01
-0.8564E 00	-0.1255E 01	-0.4560E-02	-0.1221E 01
0.6809E-03	-0.8759E 00	-0.2223E-02	-0.8521E 00
0.8531E 00	-0.2649E-00	-0.2119E-03	-0.2626E-00
0.1204E 01	0.7867E-01	-0.1461E-04	0.6724E-01
0.1473E 01	0.4177E-00	-0.4713E-03	0.3921E-00

OUTBOUND ERROR ANALYSIS

CLASS EX---0,0---C VENUS-CLOSE-RETURN

VOL/W	VOC/W	DELRL	DELRC
0.1242E 01	0.4324E-00	-0.1522E-03	0.2222E-00
0.1075E 01	0.8704E 00	-0.6199E-03	0.4497E-00
0.8778E 00	0.1004E 01	-0.8257E-03	0.5194E 00
0.6208E 00	0.1065E 01	-0.9341E-03	0.5523E 00
0.3688E-04	0.9825E 00	-0.8001E-03	0.5112E 00
-0.6213E 00	0.6352E 00	-0.3386E-03	0.3321E-00
-0.8789E 00	0.3874E-00	-0.1279E-03	0.2035E-00
-0.1077E 01	0.1137E-00	-0.1340E-04	0.6363E-01
-0.1244E 01	-0.5098E 00	-0.2143E-03	-0.2644E-00
-0.1078E 01	-0.8720E 00	-0.6309E-03	-0.4536E-00
-0.8803E 00	-0.9998E 00	-0.3294E-03	-0.5203E 00
-0.6224E 00	-0.1069E 01	-0.9475E-03	-0.5562E 00
0.4539E-04	-0.9826E 00	-0.8001E-03	-0.5113E 00
0.6219E 00	-0.6323E 00	-0.3325E-03	-0.3293E-00
0.8792E 00	-0.3936E-00	-0.1303E-03	-0.2056E-00
0.1076E 01	-0.1212E-00	-0.1340E-04	-0.6448E-01

OUTBOUND ERROR ANALYSIS

CLASS EX---0,0---D VENUS-OPT-RETURN

VOL/W	VOC/W	DELRL	DELRC
0.1374E 01	0.6773E 00	-0.3946E-02	0.1136E 01
0.1188E 01	0.1071E 01	-0.1051E-01	0.1853E 01
0.9700E 00	0.1164E 01	-0.1270E-01	0.2037E 01
0.6862E 00	0.1177E 01	-0.1328E-01	0.2083E 01
0.3518E-03	0.9669E 00	-0.9435E-02	0.1756E 01
-0.6895E 00	0.4960E-00	-0.2745E-02	0.9472E 00
-0.9772E 00	0.2008E-00	-0.5529E-03	0.4247E-00
-0.1199E 01	-0.1077E-00	-0.5237E-04	-0.1293E-00
-0.1390E 01	-0.7060E 00	-0.4576E-02	-0.1223E 01
-0.1206E 01	-0.1072E 01	-0.1110E-01	-0.1905E 01
-0.9846E 00	-0.1162E 01	-0.1322E-01	-0.2079E 01
-0.6958E 00	-0.1174E 01	-0.1363E-01	-0.2111E 01
0.3965E-03	-0.9631E 00	-0.9375E-02	-0.1751E 01
0.6925E 00	-0.4959E-00	-0.2666E-02	-0.9334E 00
0.9772E 00	-0.2030E-00	-0.5395E-03	-0.4196E-00
0.1194E 01	0.1037E-00	-0.4384E-04	0.1193E-00

OUTBOUND ERROR ANALYSIS

CLASS EX---0,0---D VENUS-CLOSE-RETURN

VOL/W	VOC/W	DELRL	DELRC
0.2716E 01	0.1602E 01	-0.2309E-01	0.2747E 01
0.2354E 01	0.1716E 01	-0.2700E-01	0.2971E 01
0.1927E 01	0.1595E 01	-0.2365E-01	0.2780E 01
0.1368E 01	0.1364E 01	-0.1762E-01	0.2400E 01
0.3217E-02	0.6460E 00	-0.4214E-02	0.1174E 01
-0.1389E 01	-0.2381E-00	-0.4847E-03	-0.3980E-00
-0.1975E 01	-0.6672E 00	-0.4261E-02	-0.1180E 01
-0.2429E 01	-0.1050E 01	-0.1089E-01	-0.1887E 01
-0.2819E 01	-0.1608E 01	-0.2627E-01	-0.2931E 01
-0.2439E 01	-0.1684E 01	-0.2887E-01	-0.3072E 01
-0.1986E 01	-0.1567E 01	-0.2488E-01	-0.2852E 01
-0.1398E 01	-0.1342E 01	-0.1813E-01	-0.2435E 01
0.3257E-02	-0.6404E 00	-0.4143E-02	-0.1164E 01
0.1378E 01	0.2373E-00	-0.4530E-03	0.3847E-00
0.1938E 01	0.6698E 00	-0.3945E-02	0.1135E 01
0.2364E 01	0.1058E 01	-0.9961E-02	0.1804E 01

OUTBOUND ERROR ANALYSIS

CLASS BI--1/2,1--H MARS-OPT-RETURN

VOL/W	VOC/W	DELRL	DELRC
0.1395E 01	0.6676E 00	-0.1665E-01	0.3270E 01
0.1205E 01	0.1055E 01	-0.4245E-01	0.5221E 01
0.9841E 00	0.1146E 01	-0.5070E-01	0.5706E 01
0.6965E 00	0.1159E 01	-0.5253E-01	0.5808E 01
0.7561E-03	0.9508E 00	-0.3647E-01	0.4839E 01
-0.7009E 00	0.4860E-00	-0.9971E-02	0.2530E 01
-0.9945E 00	0.1950E-00	-0.1718E-02	0.1050E 01
-0.1222E 01	-0.1090E-00	-0.4162E-03	-0.5153E 00
-0.1418E 01	-0.6914E 00	-0.1954E-01	-0.3542E 01
-0.1231E 01	-0.1055E 01	-0.4584E-01	-0.5425E 01
-0.1005E 01	-0.1143E 01	-0.5368E-01	-0.5871E 01
-0.7097E 00	-0.1154E 01	-0.5442E-01	-0.5911E 01
0.8348E-03	-0.9458E 00	-0.3611E-01	-0.4815E 01
0.7052E 00	-0.4864E-00	-0.9559E-02	-0.2477E 01
0.9941E 00	-0.1985E-00	-0.1670E-02	-0.1034E 01
0.1214E 01	0.1032E-00	-0.3421E-03	0.4674E-00

OUTBOUND ERROR ANALYSIS

CLASS BI--1/2,1--H MARS-CLOSE-RETURN

VOL/W	VOC/W	DELRL	DELRC
0.2035E 01	0.1263E 01	-0.5930E-01	0.6171E 01
0.1760E 01	0.1492E 01	-0.8389E-01	0.7339E 01
0.1440E 01	0.1455E 01	-0.8075E-01	0.7200E 01
0.1022E 01	0.1318E 01	-0.6731E-01	0.6574E 01
0.2985E-02	0.7889E 00	-0.2511E-01	0.4016E 01
-0.1037E 01	0.4944E-01	-0.1292E-03	0.2851E-00
-0.1475E 01	-0.3364E-00	-0.4564E-02	-0.1712E 01
-0.1817E 01	-0.6973E 00	-0.2022E-01	-0.3603E 01
-0.2112E 01	-0.1271E 01	-0.6854E-01	-0.6634E 01
-0.1830E 01	-0.1472E 01	-0.9147E-01	-0.7663E 01
-0.1491E 01	-0.1434E 01	-0.8605E-01	-0.7433E 01
-0.1050E 01	-0.1299E 01	-0.6982E-01	-0.6695E 01
0.3087E-02	-0.7809E 00	-0.2461E-01	-0.3976E 01
0.1035E 01	-0.5134E-01	-0.1316E-03	-0.2879E-00
0.1455E 01	0.3330E-00	-0.4076E-02	0.1618E 01
0.1774E 01	0.6960E 00	-0.1798E-01	0.3398E 01

OUTBOUND ERROR ANALYSIS

CLASS IN---0,0---A MARS-CLOSE-RETURN

VOL/W	VOC/W	DELRL	DELRC
0.1222E 01	0.3993E-00	-0.9497E-03	0.7806E 00
0.1057E 01	0.8374E 00	-0.4206E-02	0.1643E 01
0.8631E 00	0.9777E 00	-0.5751E-02	0.1921E 01
0.6103E 00	0.1050E 01	-0.6660E-02	0.2068E 01
0.9788E-04	0.9821E 00	-0.5880E-02	0.1943E 01
-0.6112E 00	0.6498E 00	-0.2600E-02	0.1292E 01
-0.8650E 00	0.4106E-00	-0.1045E-02	0.8189E 00
-0.1060E 01	0.1442E-00	-0.1316E-03	0.2900E-00
-0.1226E 01	-0.4451E-00	-0.1218E-02	-0.8837E 00
-0.1062E 01	-0.8388E 00	-0.4330E-02	-0.1667E 01
-0.8674E 00	-0.9768E 00	-0.5863E-02	-0.1940E 01
-0.6133E 00	-0.1050E 01	-0.6753E-02	-0.2082E 01
0.1064E-03	-0.9813E 00	-0.5871E-02	-0.1941E 01
0.6124E 00	-0.6495E 00	-0.2560E-02	-0.1282E 01
0.8655E 00	-0.4123E-00	-0.1033E-02	-0.8137E 00
0.1059E 01	-0.1453E-00	-0.1316E-03	-0.2884E-00

OUTBOUND ERROR ANALYSIS

CLASS IN---0,0---B MARS-CLOSE-RETURN

VOL/W	VOC/W	DELRL	DELRC
0.1109E 01	0.2074E-00	-0.1220E-03	0.2772E-00
0.9600E 00	0.6795E 00	-0.1294E-02	0.9112E 00
0.7838E 00	0.8537E 00	-0.2048E-02	0.1146E 01
0.5542E 00	0.9667E 00	-0.2631E-02	0.1299E 01
0.5674E-05	0.9966E 00	-0.2811E-02	0.1343E 01
-0.5545E 00	0.7583E 00	-0.1639E-02	0.1025E 01
-0.7843E 00	0.5582E 00	-0.8899E-03	0.7556E 00
-0.9609E 00	0.3215E-00	-0.2966E-03	0.4360E-00
-0.1110E 01	-0.2082E-00	-0.1244E-03	-0.2808E-00
-0.9616E 00	-0.6802E 00	-0.1318E-02	-0.9195E 00
-0.7852E 00	-0.8523E 00	-0.2067E-02	-0.1152E 01
-0.5552E 00	-0.9679E 00	-0.2663E-02	-0.1307E 01
0.1135E-04	-0.9954E 00	-0.2804E-02	-0.1342E 01
0.5549E 00	-0.7588E 00	-0.1624E-02	-0.1021E 01
0.7846E 00	-0.5588E 00	-0.8803E-03	-0.7515E 00
0.9607E 00	-0.3201E-00	-0.2395E-03	-0.4306E-00

OUTBOUND ERROR ANALYSIS

CLASS IN---0,0---C MARS-CLOSE-RETURN

VOL/W	VOC/W	DELRL	DELRC
0.1035E 01	0.6915E-01	-0.4784E-05	0.5152E-01
0.8962E 00	0.5679E 00	-0.2823E-03	0.4246E-00
0.7318E 00	0.7653E 00	-0.5119E-03	0.5725E 00
0.5174E 00	0.9076E 00	-0.7201E-03	0.6793E 00
-0.3405E-04	0.1006E 01	-0.8875E-03	0.7540E 00
-0.5175E 00	0.8395E 00	-0.6196E-03	0.6300E 00
-0.7319E 00	0.6631E 00	-0.3875E-03	0.4980E-00
-0.8964E 00	0.4540E-00	-0.1818E-03	0.3412E-00
-0.1035E 01	-0.1596E-00	-0.2392E-04	-0.1197E-00
-0.8966E 00	-0.5659E 00	-0.2823E-03	-0.4249E-00
-0.7321E 00	-0.7608E 00	-0.5095E-03	-0.5711E 00
-0.5177E 00	-0.9069E 00	-0.7225E-03	-0.6805E 00
-0.2837E-04	-0.1004E 01	-0.8851E-03	-0.7528E 00
0.5176E 00	-0.8383E 00	-0.6148E-03	-0.6277E 00
0.7319E 00	-0.6635E 00	-0.3852E-03	-0.4966E-00
0.8964E 00	-0.4432E-00	-0.1770E-03	-0.3354E-00

OUTBOUND ERROR ANALYSIS

CLASS BI--1/2,1--H VENUS-OPT

VOL/W	VOC/W	DELRL	DELRC
0.1343E 01	0.6830E 00	-0.1143E-01	0.2316E 01
0.1160E 01	0.1036E 01	-0.3243E-01	0.3901E 01
0.9466E 00	0.1183E 01	-0.3996E-01	0.4331E 01
0.6696E 00	0.1198E 01	-0.4256E-01	0.4470E 01
0.2007E-03	0.9876E 00	-0.3150E-01	0.3845E 01
-0.6746E 00	0.5096E 00	-0.9915E-02	0.2157E 01
-0.9571E 00	0.2091E-00	-0.2313E-02	0.1042E 01
-0.1176E 01	-0.1054E-00	-0.5246E-04	-0.1544E-00
-0.1365E 01	-0.7087E 00	-0.1351E-01	-0.2518E 01
-0.1186E 01	-0.1089E 01	-0.3521E-01	-0.4065E 01
-0.9685E 00	-0.1182E 01	-0.4252E-01	-0.4467E 01
-0.6844E 00	-0.1194E 01	-0.4430E-01	-0.4560E 01
0.2936E-03	-0.9822E 00	-0.3128E-01	-0.3832E 01
0.6793E 00	-0.5093E 00	-0.9505E-02	-0.2112E 01
0.9577E 00	-0.2125E-00	-0.2229E-02	-0.1023E 01
0.1169E 01	0.9922E-01	-0.3672E-04	0.1279E-00

OUTBOUND ERROR ANALYSIS

CLASS BI--1/2,1--H VENUS-CLOSE

VOL/W	VOC/W	DELRL	DELRC
0.4249E 01	0.1942E 01	-0.9783E-01	0.6776E 01
0.3694E 01	0.1907E 01	-0.9688E-01	0.6743E 01
0.3035E 01	0.1686E 01	-0.7776E-01	0.6041E 01
0.2165E 01	0.1349E 01	-0.5161E-01	0.4921E 01
0.6678E-02	0.4359E-00	-0.6145E-02	0.1698E 01
-0.2247E 01	-0.5693E 00	-0.9705E-02	-0.2134E 01
-0.3213E 01	-0.1020E 01	-0.3324E-01	-0.3950E 01
-0.3968E 01	-0.1395E 01	-0.6465E-01	-0.5508E 01
-0.4620E 01	-0.1864E 01	-0.1198E-00	-0.7499E 01
-0.3980E 01	-0.1805E 01	-0.1110E-00	-0.7219E 01
-0.3226E 01	-0.1604E 01	-0.8611E-01	-0.6357E 01
-0.2259E 01	-0.1295E 01	-0.5483E-01	-0.5073E 01
0.6743E-02	-0.4291E-00	-0.5966E-02	-0.1673E 01
0.2177E 01	0.5761E 00	-0.8635E-02	0.2013E 01
0.3049E 01	0.1047E 01	-0.2869E-01	0.3670E 01
0.3706E 01	0.1449E 01	-0.5462E-01	0.5063E 01

OUTBOUND ERROR ANALYSIS

CLASS EX---0,0---A VENUS-OPT

VOL/W	VOC/W	DELRL	DELRC
0.1397E 01	0.6706E 00	-0.2686E-02	0.1123E 01
0.1209E 01	0.1059E 01	-0.6870E-02	0.1796E 01
0.9869E 00	0.1149E 01	-0.8161E-02	0.1957E 01
0.6982E 00	0.1161E 01	-0.8421E-02	0.1988E 01
0.3319E-03	0.9525E 00	-0.5807E-02	0.1651E 01
-0.7003E 00	0.4834E-00	-0.1595E-02	0.8648E 00
-0.9918E 00	0.1076E-00	-0.2850E-03	0.3651E-00
-0.1216E 01	-0.1069E-00	-0.5770E-04	-0.1623E-00
-0.1408E 01	-0.7098E 00	-0.3144E-02	-0.1214E 01
-0.1221E 01	-0.1059E 01	-0.7112E-02	-0.1827E 01
-0.9966E 00	-0.1148E 01	-0.8392E-02	-0.1984E 01
-0.7044E 00	-0.1159E 01	-0.8568E-02	-0.2005E 01
0.3532E-03	-0.9502E 00	-0.5779E-02	-0.1647E 01
0.7022E 00	-0.4882E-00	-0.1562E-02	-0.8557E 00
0.9916E 00	-0.1989E-00	-0.2798E-03	-0.3619E-00
0.1213E 01	0.1039E-00	-0.5246E-04	0.1544E-00

OUTBOUND ERROR ANALYSIS

CLASS EX---0,0---A VENUS-CLOSE

VOL/W	VOC/W	DELRL	DELRC
0.2141E 01	0.1317E 01	-0.1050E-01	0.2220E 01
0.1853E 01	0.1530E 01	-0.1431E-01	0.2591E 01
0.1515E 01	0.1478E 01	-0.1346E-01	0.2514E 01
0.1073E 01	0.1325E 01	-0.1093E-01	0.2265E 01
0.1488E-02	0.7678E 00	-0.3773E-02	0.1331E 01
-0.1081E 01	0.5711E-02	-0.1749E-05	0.2433E-01
-0.1533E 01	-0.3865E-00	-0.9215E-03	-0.6571E 00
-0.1883E 01	-0.7530E 00	-0.3592E-02	-0.1298E 01
-0.2181E 01	-0.1357E 01	-0.1189E-01	-0.2362E 01
-0.1889E 01	-0.1517E 01	-0.1487E-01	-0.2641E 01
-0.1541E 01	-0.1468E 01	-0.1388E-01	-0.2552E 01
-0.1087E 01	-0.1316E 01	-0.1112E-01	-0.2285E 01
0.1511E-02	-0.7641E 00	-0.3739E-02	-0.1324E 01
0.1080E 01	-0.6737E-02	-0.1749E-05	-0.2569E-01
0.1522E 01	0.3850E-00	-0.8743E-03	0.6400E 00
0.1860E 01	0.7519E 00	-0.3391E-02	0.1261E 01

OUTBOUND ERROR ANALYSIS

CLASS EX---0,0---C VENUS-OPT

VCL/W	VOC/W	DELRL	DELRC
0.1400E 01	0.6699E 00	-0.2278E-02	0.1034E 01
0.1211E 01	0.1057E 01	-0.5797E-02	0.1649E 01
0.9886E 00	0.1148E 01	-0.6897E-02	0.1799E 01
0.6994E 00	0.1160E 01	-0.7098E-02	0.1825E 01
0.3092E-03	0.9518E 00	-0.4884E-02	0.1514E 01
-0.7013E 00	0.4871E-00	-0.1329E-02	0.7893E 00
-0.9931E 00	0.1970E-00	-0.2343E-03	0.3309E-00
-0.1218E 01	-0.1058E-00	-0.5071E-04	-0.1506E-00
-0.1409E 01	-0.7160E 00	-0.2710E-02	-0.1128E 01
-0.1222E 01	-0.1057E 01	-0.5987E-02	-0.1676E 01
-0.9975E 00	-0.1146E 01	-0.7057E-02	-0.1820E 01
-0.7050E 00	-0.1158E 01	-0.7208E-02	-0.1839E 01
0.3319E-03	-0.9492E 00	-0.4858E-02	-0.1510E 01
0.7031E 00	-0.4878E-00	-0.1308E-02	-0.7830E 00
0.9929E 00	-0.2001E-00	-0.2361E-03	-0.3315E-00
0.1215E 01	0.1039E-00	-0.4546E-04	0.1452E-00

OUTBOUND ERROR ANALYSIS

CLASS EX---0,0---C VENUS-CLOSE

VOL/W	VOC/W	DELRL	DELRÇ
0.2007E 01	0.1233E 01	-0.7797E-02	0.1913E 01
0.1737E 01	0.1471E 01	-0.1121E-01	0.2294E 01
0.1419E 01	0.1441E 01	-0.1083E-01	0.2254E 01
0.1005E 01	0.1311E 01	-0.9039E-02	0.2060E 01
0.1192E-02	0.8003E 00	-0.3453E-02	0.1273E 01
-0.1011E 01	0.7564E-01	-0.3847E-04	0.1322E-00
-0.1434E 01	-0.3063E-00	-0.4844E-03	-0.4762E-00
-0.1760E 01	-0.6650E 00	-0.2355E-02	-0.1051E 01
-0.2038E 01	-0.1265E 01	-0.8675E-02	-0.2018E 01
-0.1766E 01	-0.1464E 01	-0.1164E-01	-0.2337E 01
-0.1441E 01	-0.1432E 01	-0.1111E-01	-0.2284E 01
-0.1017E 01	-0.1304E 01	-0.9194E-02	-0.2077E 01
0.1224E-02	-0.7960E 00	-0.3417E-02	-0.1266E 01
0.1011E 01	-0.7618E-01	-0.3847E-04	-0.1313E-00
0.1426E 01	0.3044E-00	-0.4599E-03	0.4641E-00
0.1743E 01	0.6644E 00	-0.2243E-02	0.1026E 01

OUTBOUND ERROR ANALYSIS

CLASS EX---0,0---D VENUS-OPT

VOL/W	VOC/W	DELRL	DELRC
0.1401E 01	0.6696E 00	-0.2081E-02	0.9881E 00
0.1212E 01	0.1057E 01	-0.5284E-02	0.1575E 01
0.9895E 00	0.1148E 01	-0.6281E-02	0.1717E 01
0.6999E 00	0.1160E 01	-0.6470E-02	0.1743E 01
0.2936E-03	0.9511E 00	-0.4436E-02	0.1443E 01
-0.7018E 00	0.4878E-00	-0.1208E-02	0.7528E 00
-0.9938E 00	0.1970E-00	-0.2116E-03	0.3142E-00
-0.1219E 01	-0.1056E-00	-0.4546E-04	-0.1449E-00
-0.1410E 01	-0.7213E 00	-0.2511E-02	-0.1085E 01
-0.1222E 01	-0.1058E 01	-0.5459E-02	-0.1601E 01
-0.9979E 00	-0.1146E 01	-0.6419E-02	-0.1736E 01
-0.7053E 00	-0.1157E 01	-0.6557E-02	-0.1754E 01
0.3107E-03	-0.9492E 00	-0.4420E-02	-0.1440E 01
0.7035E 00	-0.4884E-00	-0.1191E-02	-0.7471E 00
0.9936E 00	-0.1990E-00	-0.2116E-03	-0.3134E-00
0.1215E 01	0.1037E-00	-0.4372E-04	0.1399E-00

OUTBOUND ERROR ANALYSIS

CLASS EX---0,0---D VENUS-CLOSE

VOL/W	VOC/W	DELRL	DELRC
0.1939E 01	0.1185E 01	-0.6580E-02	0.1757E 01
0.1678E 01	0.1439E 01	-0.9787E-02	0.2143E 01
0.1371E 01	0.1418E 01	-0.9568E-02	0.2119E 01
0.9707E 00	0.1302E 01	-0.8131E-02	0.1953E 01
0.1048E-02	0.8175E 00	-0.3279E-02	0.1240E 01
-0.9760E 00	0.1142E-00	-0.7344E-04	0.1840E-00
-0.1384E 01	-0.2607E-00	-0.3182E-03	-0.3854E-00
-0.1699E 01	-0.6147E 00	-0.1829E-02	-0.9261E 00
-0.1966E 01	-0.1239E 01	-0.7566E-02	-0.1884E 01
-0.1703E 01	-0.1434E 01	-0.1015E-01	-0.2183E 01
-0.1390E 01	-0.1411E 01	-0.9820E-02	-0.2147E 01
-0.9814E 00	-0.1296E 01	-0.8259E-02	-0.1969E 01
0.1074E-02	-0.8133E 00	-0.3245E-02	-0.1234E 01
0.9761E 00	-0.1150E-00	-0.7169E-04	-0.1828E-00
0.1377E 01	0.2583E-00	-0.3008E-03	0.3751E-00
0.1683E 01	0.6147E 00	-0.1750E-02	0.9062E 00

OUTBOUND ERROR ANALYSIS

CLASS BI--1/2,1--H MARS-OPT

VOL/W	VOC/W	DELRL	DELRC
0.1361E 01	0.6800E 00	-0.8893E-02	0.2043E 01
0.1176E 01	0.1078E 01	-0.2434E-01	0.3380E 01
0.9596E 00	0.1172E 01	-0.2965E-01	0.3731E 01
0.6789E 00	0.1186E 01	-0.3127E-01	0.3831E 01
0.3348E-03	0.9757E 00	-0.2263E-01	0.3259E 01
-0.6831E 00	0.5014E 00	-0.6818E-02	0.1789E 01
-0.9687E 00	0.2038E-00	-0.1464E-02	0.8285E 00
-0.1190E 01	-0.1077E-00	-0.8218E-04	-0.1957E-00
-0.1380E 01	-0.7069E 00	-0.1043E-01	-0.2212E 01
-0.1198E 01	-0.1079E 01	-0.2610E-01	-0.3500E 01
-0.9783E 00	-0.1171E 01	-0.3126E-01	-0.3830E 01
-0.6913E 00	-0.1183E 01	-0.3234E-01	-0.3896E 01
0.4043E-03	-0.9709E 00	-0.2247E-01	-0.3247E 01
0.6870E 00	-0.5014E 00	-0.6571E-02	-0.1756E 01
0.9690E 00	-0.2068E-00	-0.1420E-02	-0.8161E 00
0.1184E 01	0.1020E-00	-0.6470E-04	0.1723E-00

OUTBOUND ERROR ANALYSIS

CLASS BI--1/2,1--H MARS-CLOSE

VOL/W	VOC/W	DELRL	DELRC
0.3712E 01	0.1844E 01	-0.6834E-01	0.5663E 01
0.3223E 01	0.1851E 01	-0.7040E-01	0.5748E 01
0.2644E 01	0.1658E 01	-0.5768E-01	0.5203E 01
0.1882E 01	0.1352E 01	-0.3945E-01	0.4303E 01
0.5354E-02	0.4948E-00	-0.5826E-02	0.1653E 01
-0.1935E 01	-0.4781E-00	-0.5036E-02	-0.1537E 01
-0.2759E 01	-0.9249E 00	-0.2002E-01	-0.3065E 01
-0.3402E 01	-0.1305E 01	-0.4110E-01	-0.4392E 01
-0.3954E 01	-0.1799E 01	-0.8051E-01	-0.6147E 01
-0.3413E 01	-0.1778E 01	-0.7816E-01	-0.6056E 01
-0.2772E 01	-0.1599E 01	-0.6241E-01	-0.5412E 01
-0.1946E 01	-0.1312E 01	-0.4130E-01	-0.4403E 01
0.5407E-02	-0.4886E-00	-0.5686E-02	-0.1634E 01
0.1893E 01	0.4813E-00	-0.4595E-02	0.1468E 01
0.2657E 01	0.9405E 00	-0.1782E-01	0.2892E 01
0.3234E 01	0.1338E 01	-0.3597E-01	0.4109E 01

OUTBOUND ERROR ANALYSIS

CLASS IN---0,0---A MARS-OPT

VOL/W	VOC/W	DELRL	DELRC
0.1406E 01	0.6680E 00	-0.1082E-02	0.7124E 00
0.1217E 01	0.1056E 01	-0.2730E-02	0.1132E 01
0.9938E 00	0.1146E 01	-0.3230E-02	0.1231E 01
0.7029E 00	0.1158E 01	-0.3315E-02	0.1247E 01
0.2128E-03	0.9488E 00	-0.2254E-02	0.1028E 01
-0.7042E 00	0.4854E-00	-0.6015E-03	0.5312E 00
-0.9969E 00	0.1985E-00	-0.1049E-03	0.2211E-00
-0.1222E 01	-0.1042E-00	-0.2623E-04	-0.1075E-00
-0.1413E 01	-0.7339E 00	-0.1343E-02	-0.7935E 00
-0.1225E 01	-0.1056E 01	-0.2791E-02	-0.1144E 01
-0.9998E 00	-0.1144E 01	-0.3282E-02	-0.1241E 01
-0.7068E 00	-0.1153E 01	-0.3333E-02	-0.1251E 01
0.2298E-03	-0.9462E 00	-0.2242E-02	-0.1025E 01
0.7054E 00	-0.4833E-00	-0.6015E-03	-0.5310E 00
0.9967E 00	-0.2001E-00	-0.1049E-03	-0.2207E-00
0.1220E 01	0.1017E-00	-0.2448E-04	0.1036E-00

OUTBOUND ERROR ANALYSIS

CLASS IN---0,0---A MARS-CLOSE

VOL/W	VOC/W	DELRL	DELRC
0.1555E 01	0.8426E 00	-0.1726E-02	0.8997E 00
0.1346E 01	0.1192E 01	-0.3476E-02	0.1277E 01
0.1099E 01	0.1244E 01	-0.3805E-02	0.1336E 01
0.7776E 00	0.1213E 01	-0.3637E-02	0.1307E 01
0.3631E-03	0.9136E 00	-0.2090E-02	0.9900E 00
-0.7795E 00	0.3692E-00	-0.3515E-03	0.4050E-00
-0.1104E 01	0.4984E-01	-0.8743E-05	0.5924E-01
-0.1353E 01	-0.2754E-00	-0.1854E-03	-0.2942E-00
-0.1565E 01	-0.9080E 00	-0.2065E-02	-0.9841E 00
-0.1356E 01	-0.1188E 01	-0.3546E-02	-0.1290E 01
-0.1107E 01	-0.1242E 01	-0.3871E-02	-0.1348E 01
-0.7826E 00	-0.1211E 01	-0.3679E-02	-0.1314E 01
0.3745E-03	-0.9119E 00	-0.2081E-02	-0.9882E 00
0.7806E 00	-0.3690E-00	-0.3445E-03	-0.4019E-00
0.1103E 01	-0.5123E-01	-0.8743E-05	-0.6012E-01
0.1349E 01	0.2685E-00	-0.1714E-03	0.2832E-00

OUTBOUND ERROR ANALYSIS

CLASS IN---0,0---B MARS-OPT

VOL/W	VOC/W	DELRL	DELRC
0.1406E 01	0.6681E 00	-0.1114E-02	0.7225E 00
0.1217E 01	0.1056E 01	-0.2808E-02	0.1148E 01
0.9936E 00	0.1146E 01	-0.3321E-02	0.1248E 01
0.7028E 00	0.1157E 01	-0.3406E-02	0.1264E 01
0.2156E-03	0.9490E 00	-0.2319E-02	0.1043E 01
-0.7041E 00	0.4865E-00	-0.6225E-03	0.5402E 00
-0.9968E 00	0.1984E-00	-0.1084E-03	0.2243E-00
-0.1222E 01	-0.1047E-00	-0.2623E-04	-0.1094E-00
-0.1413E 01	-0.7381E 00	-0.1397E-02	-0.8095E 00
-0.1224E 01	-0.1054E 01	-0.2862E-02	-0.1159E 01
-0.9998E 00	-0.1144E 01	-0.3377E-02	-0.1259E 01
-0.7067E 00	-0.1155E 01	-0.3441E-02	-0.1271E 01
0.2298E-03	-0.9471E 00	-0.2312E-02	-0.1041E 01
0.7054E 00	-0.4875E-00	-0.6173E-03	-0.5378E 00
0.9966E 00	-0.1997E-00	-0.1084E-03	-0.2236E-00
0.1219E 01	0.1020E-00	-0.2448E-04	0.1053E-00

OUTBOUND ERROR ANALYSIS

CLASS IN---0,0---B MARS-CLOSE

VOL/W	VOC/W	DELRL	DELRC
0.1568E 01	0.8569E 00	-0.1836E-02	0.9280E 00
0.1357E 01	0.1203E 01	-0.3644E-02	0.1308E 01
0.1108E 01	0.1252E 01	-0.3966E-02	0.1364E 01
0.7842E 00	0.1219E 01	-0.3777E-02	0.1331E 01
0.3830E-03	0.9104E 00	-0.2135E-02	0.1001E 01
-0.7862E 00	0.3598E-00	-0.3427E-03	0.4006E-00
-0.1113E 01	0.3938E-01	-0.6994E-05	0.4869E-01
-0.1365E 01	-0.2868E-00	-0.2081E-03	-0.3110E-00
-0.1579E 01	-0.9264E 00	-0.2212E-02	-0.1019E 01
-0.1368E 01	-0.1200E 01	-0.3721E-02	-0.1321E 01
-0.1117E 01	-0.1252E 01	-0.4046E-02	-0.1378E 01
-0.7893E 00	-0.1215E 01	-0.3812E-02	-0.1337E 01
0.3944E-03	-0.9078E 00	-0.2123E-02	-0.9981E 00
0.7873E 00	-0.3602E-00	-0.3392E-03	-0.3981E-00
0.1112E 01	-0.3994E-01	-0.6994E-05	-0.4879E-01
0.1360E 01	0.2822E-00	-0.1958E-03	0.3020E-00

OUTBOUND ERROR ANALYSIS

CLASS IN---0,0---C MARS-OPT

VOL/W	VOC/W	DELRL	DELRC
0.1408E 01	0.6676E 00	-0.8096E-03	0.6161E 00
0.1219E 01	0.1056E 01	-0.2039E-02	0.9780E 00
0.9950E 00	0.1145E 01	-0.2406E-02	0.1062E 01
0.7037E 00	0.1156E 01	-0.2464E-02	0.1075E 01
0.1872E-03	0.9483E 00	-0.1675E-02	0.8864E 00
-0.7049E 00	0.4874E-00	-0.4511E-03	0.4591E-00
-0.9977E 00	0.1984E-00	-0.7694E-04	0.1893E-00
-0.1223E 01	-0.1016E-00	-0.1923E-04	-0.9158E-01
-0.1414E 01	-0.7370E 00	-0.1011E-02	-0.6883E 00
-0.1225E 01	-0.1055E 01	-0.2076E-02	-0.9866E 00
-0.1000E 01	-0.1143E 01	-0.2439E-02	-0.1070E 01
-0.7071E 00	-0.1153E 01	-0.2481E-02	-0.1079E 01
0.1872E-03	-0.9480E 00	-0.1673E-02	-0.8862E 00
0.7059E 00	-0.4869E-00	-0.4441E-03	-0.4560E-00
0.9975E 00	-0.2010E-00	-0.7869E-04	-0.1903E-00
0.1221E 01	0.1012E-00	-0.1923E-04	0.9034E-01

OUTBOUND ERROR ANALYSIS

CLASS IN---0,0---C MARS-CLOSE

VOL/W	VOC/W	DELRL	DELRC
0.1435E 01	0.7010E 00	-0.8935E-03	0.6471E 00
0.1242E 01	0.1080E 01	-0.2137E-02	0.1001E 01
0.1014E 01	0.1163E 01	-0.2485E-02	0.1080E 01
0.7171E 00	0.1168E 01	-0.2514E-02	0.1086E 01
0.2014E-03	0.9419E 00	-0.1652E-02	0.8804E 00
-0.7183E 00	0.4650E-00	-0.4109E-03	0.4381E-00
-0.1017E 01	0.1713E-00	-0.5770E-04	0.1639E-00
-0.1246E 01	-0.1345E-00	-0.3322E-04	-0.1224E-00
-0.1441E 01	-0.7704E 00	-0.1105E-02	-0.7198E 00
-0.1249E 01	-0.1083E 01	-0.2191E-02	-0.1014E 01
-0.1019E 01	-0.1164E 01	-0.2527E-02	-0.1089E 01
-0.7206E 00	-0.1165E 01	-0.2530E-02	-0.1090E 01
0.2156E-03	-0.9411E 00	-0.1649E-02	-0.8796E 00
0.7193E 00	-0.4656E-00	-0.4057E-03	-0.4362E-00
0.1016E 01	-0.1710E-00	-0.5770E-04	-0.1624E-00
0.1244E 01	0.1341E-00	-0.3322E-04	0.1209E-00

Appendix B

Program 7

```
1FUNK    CPTIMUM 2-STAGE TRAJECTORY

      DIMENSICN FII(21),RO(10),VO(1C),HEAD(12)
 800  READ INPUT TAPE 2,200,HEAD,G,VIN,RIN,RS,FIIN,DFI,RCIN,DRCIN,
 800 1VE,RE,GE,CDVI,IC1,NCRM1,NCRM2,L,M,N,PCERR
 200  FCRMAT(12A6,/8E9.0,/4E10.C,I5,/2I5,/3I5,E10.0)
 850  WRITE CUTPUT TAPE 3,300,HEAD
 300  FCRMAT(27H1CPTIMUM 2-STAGE TRAJECTORY//12A6,/)
 4    ICUAL=0
 0401 JCUAL=0
 801  READ INPUT TAPE 2,201,RMAX,RMIN
 201  FCRMAT(2E10.C)
 802  WRITE CUTPUT TAPE 3,310,RMIN,RMAX,RIN,RE,PCERR,L,
 802 1  RCIN,FIIN,VIN,VE,CDVI,M,  CRDIN,DFI,G,GE,ICI,N,  RS
 310    FCRMAT(1X,6HRMIN =,E11.4,3X,5HRMAX=,E11.4,3X,4HRIN=,E11.4,3X,
 310 1   3HRE=,E11.4,3X,6HPCERR=,E11.4,3X,2HL=,I3 /  1X,6HRCIN =,E11.4,
 310 2   3X,5HFIIN=,E11.4,3X,4HVIN=,E11.4,3X,3HVE=,E11.4,3X,6HCDVI  =,
 310 3   E11.4,3X,2HM=,I3 /  1X,6HDROIN=,E11.4,3X,5HDFI =,E11.4,3X,
 310 4   4HG  =,E11.4,3X,3HGE=,E11.4,3X,6HICI  =,I3,11X,2HN=,I3 /
 310 5   1X,6HRS   =,E11.4)
 0402 KCUAL=0
 0403 K2CUAL=0
 0404 ACRCY=1.+PCERR
 17   PI=3.1415927
 803  READ INPUT TAPE 2,203,DATA
 203  FCRMAT (E10.0)
      IF(NCRM1) 101,101,1
C NON-NCRMALIZE
 1    RS=RS*RE
 0102 VIN=VIN*VE
 0103 G=G*GE
      GC TC 104
C     NCRMALIZE TC PLANET PARAMETERS
 101  RIN=RIN/RS
      RCIN=RCIN/RS
      DRCIN=DRCIN/RS
      RMAX = RMAX/RS
      RMIN = RMIN/RS
 104  VCS=SCRTF(G/RS)
      VIN=VIN/VCS
C     CCNVERT ANGLES DEGREES-TO-RACIANS
 0106 FIIN=.017453293*FIIN
 0107 DFI=.017453293*DFI
C     CALCULATE REF. OPTIMUMS .
 0108 VINSC=VIN**2
      PE=1.0/RIN
      PE2=PE*2.0
      E=VINSC/2.0-PE
      CPTRCN=1.0/E
      CPTRC=CPTRCN*RS
```

```
1FUNK   CPTIMUM 2-STAGE TRAJECTORY

      CPTCVN=SCRTF(E)
      CPTCV=OPTCVN*VCS
      CPTDVE=CPTCV/VE
      CPTH=2.0/CPTCVN
      SCPTFI=CPTH/(RIN*VIN)
      CPTFI=ASIN(SOPTFI)
      OPTFI=OPTFI*57.295780
 0109 WRITE CUTPUT TAPE 3,316,OPTRON, CPTDVE,OPTFI,OPTRC, CPTDV
 316  FCRMAT(1X,12HCPTRCN      =,E15.8,12X,10HOPTDVE   =,E15.8,10X,
 316 1  6HCPTFI=,E15.8 /  1X,12HOPTDV(KM/S)=,E15.8,12X,1CHOPTRO(KM)=,
 316 2  E15.8)
C GENERATE FII(I) MATRIX
 2    FII(1)=FIIN
      DC31=2,L
 3    FII(I)=FII(I-1)+DFI
 42   WRITE CUTPUT TAPE 3,306
 306  FCRMAT(/2X,9H FI INIT.,3X,11H ORB.RADIUS,3X,9H TCTAL DV,3X,
 306 111H DV AT CRB.,2X,10H DV AT RIN ,  6X, 3H FI , 9X,
 306 2  4H PSI , 1CX, 2H V )
 4201 IF(NCRM2)45,45,4402
 4402 WRITE OUTPUT TAPE 3,301
 301  FCRMAT(3X,7HDEGREES, 8X,3H/RS,    8X,3(7H/OPT.DV,6X),
 301 1 2(7HDEGREES,7X),3H/VE,/)
 4401 GC TC 5
 45   WRITE CUTPUT TAPE 3,302
 302  FCRMAT(3X,7HDEGREES,6X,1CHKILCMETERS,3(3X,10HKM./SECOND),
 302 1 2(4X,7HDEGREES),5X,10HKM./SECOND,/)
C START LCCP FCR EACH INIT. CONC.
 5    DC 50 I=1,L
C     RESET OPTIMUM FOR NEXT I.C.
 0501 PCCVT=OCVI
 0502 IC2=ICI
  503 CUT2=0
C GENERATE RO(J) MATRIX
 6    RC(1)=RCIN
 0601 DRC=DRCIN
 7    DC8J=2,M
 8    RC(J)=RC(J-1)+DRO
C     RESET CPT FCR NEXT SET OF RO(J)
      SCDVT= CCVI
C  START LCCP FCR EACH ORBITAL RADIUS
 9    DC 36 J=1,M
 0911 IF(RMAX-RC(J)) 36,0912,0912
 0912 IF(RC(J)-RMIN) 36,0901,0901
C     RESET CPT. FCR NEXT RADIUS
 0901 OCDVT=OCVI
 0902 IC1=ICI
 0903 OUT1=0
```

```
 1FUNK   CPTIMUM 2-STAGE TRAJECTORY

C  START PRELIM. CALC. BASED ON RO(I)
       VCSQ=1.0/RO(J)
       VC=SCRTF(VCSC)
       VPARSC=2.0*VCSQ
       VPAR=SQRTF(VPARSQ)
       CVC=(SCRTF(VINSQ+VPARSQ)-VPAR)/ 9.0
C  GENERATE VC(K) MATRIX
 11    VC(1)=VPAR+(CVO/2.)
 12    DC13K=2,10
 13    VC(K)=VC(K-1)+CVO
C      RESET OPTIMUM FCR NEXT SET OF VO(K)
       OCVT=ODVI
C   START LCOP FOR EACHVO
 14    DC25K=1,10
C   TEST FCR NCN-HYPERBOLIC PATHS
 15    IF(VC(K)-VPAR)25,25,16
C   START CALC. FCR + VALUES
 16    CVC=VC(K)-VC
 1601  ZA=VO(K)**2-VPARSQ
       H=RC(J)*VC(K)
       VSC=PE2+ZA
       V=SCRTF(VSC)
       SFI=H/(RIN*V)
       FI=ASIN (SFI)
       DELFI=FI-FII(I)
 1602  CDELFI=CCSF(CELFI)
 1603  SDELFI=SINF(CELFI)
 18    VCR=V*SDELFI
       VLG=V*CDELFI
 19    DVLG=VIN-VLG
       TTHETA=VCR/CVLG
 21    THETA=ATANF(TTHETA)
 20    CV=ABSF(VCR/SINF(THETA))
 2105  DVT=CV+CVC
C   TEST FCR CPTIMUM
 22    IF(CDVT-CVT)25,25,24
C   STORE CPTIMUMS
 24    OCVT=DVT
       OVC=VO(K)
 25    CCNTINUE
C  END CF LCOP FOR EACH VO
 26    IF(CDVT-CCDVT)27,2902,28
C  TEST CCNVERGENCE FCR VO(K)-ITERATION
 27    IF(CDVT*ACRCY-OODVT)2701,2702,2702
 2701  IF(IC1-N)2703,2702,2702
 2702  CUT1=1
C  STCRE CLD CPTIMUMS
 2703  OCDVT=ODVT
```

```
 1FUNK   CPTIMUM 2-STAGE TRAJECTORY

 2705 CCVC=CVC
 2706 IF(CUT1)2707,2707,2902
 2707 IC1=IC1+1
C  BRACKET OPTIMUM VO
 2708 CVC=.1*CVC
 2781 IF(CVO-(5.0E-09))2902,2902,2782
 2782 VC(1)=OOVO-4.5*CVO
 2709 GC TC 12
C  END CF VC(K)-ITERATION LOOP
 28   IF(CCDVT*ACRCY-ODVT)2801,2902,29C2
 2801 IF(IC1-N)2707,2902,2902
 2902 IF(DRC)3C,2904,30
 2904 PCDVT=CCDVT
      PCVC=OOVO
      PCRO=RO(J)
 2906 GC TC 4102
C  TEST FCR SUPER-CPTIMUM AND STORE
 30   IF(SCDVT-CODVT)36,36,32
 32   SCDVT=OODVT
      SCVC=OCVC
 33   SCRC=RC(J)
 36   CONTINUE
C END OF LCCP FCR EACH RACIUS
 38   IF(SCDVT-PODVT)39,4102,40
C TEST CCNVERGENCE FOR RO(J)-ITERATION
 39   IF(SCDVT*ACRCY-PODVT)3901,3902,3902
 3901 IF(IC2-N)3903,3902,3902
 3902 CUT2=1
C STORE PREVICUS SUPER-OPTIMUMS
 3903 PCDVT=SCDVT
      PCVC=SOVC
 3905 PCRC=SORO
 3907 IF(CUT2)3908,3908,4102
 3908 IC2=IC2+1
C BRACKET CPTIMUM RC
 3909 DRC=.1*CRC
 3991 IF(CRO-(5.0E-09))4102,4102,3992
 3992 RC(1)=PCRC-4.5*DRO
 3910 GC TO 7
C END OF RO(J)-ITERATION LOOP
 40   IF(PCDVT*ACRCY-SODVT)4001,41C2,4102
 4001 IF(IC2-N)3908,4102,4102
C PREPARE DATA FOR OUPUT
 4102 VCSQ= 1.C/PCRC
      VC=SCRTF(VCSQ)
      PCDVC= PCVO-VC
      ZA=POVO**2-2.0*VCSQ
      H=PCRC*PCVC
```

```
1FUNK   CPTIMUM 2-STAGE TRAJECTORY

      VSC=PE2+ZA
      PCV=SCRTF(VSC )
      SFI=H/(RIN*PCV)
      PCFI=ASIN(SFI)
      CELFI=PCFI-FII(I)
      CCELFI=CCSF(CELFI)
      SCELFI=SINF(CELFI)
      VCR=PCV*SCELFI
      VLG=PCV*CCELFI
      CVLG=VIN-VLG
C   CCRRECTION ANGLE CALC.
      TTHETA=VCR/CVLG
      THETA=ATANF(TTHETA)
      PCCV=ABSF(VCR/SINF(THETA))
      IF (CVLG) 41C3,41C4,4104
C     CBTUSE ANGLE CALC.
 4103 THETA=THETA-PI
C     ACUTE ANGLE THETA CALC.
      PSI=PI-THETA+FII(I)
 4104 PCPSI=PI-THETA+FII(I)
 4105 IF(NORM2)44,44,43
C  NORMALIZE CVS ANC RO
 43   PCCVT=PCCVT/CPTCVN
      PCCVC=PCCVO/CPTCVN
      PCCV=POCV/OPTCVN
      PCV=PCV*VCS/VE
      GC TO 46
C     NCN-NCRMALIZE CVS AND RO
 44   PCCVT=PCCVT*VCS
      PCCVO=POCVO*VCS
      PCCV =POCV *VCS
      PCV  =POV  *VCS
      PCRC =PCRC *VCS
C  CCNVERT ANGLES RADIANS-TO-CEGREES
 46   PCFI=POFI*57.295780
      PCPSI=POPSI*57.295780
 47   FII(I)=FII(I)*57.295780
 48   IF(PCPSI-18C.)50,50,49
 49   PCPSI=PCPSI-360.
 50   WRITE CUTPUT TAPE 3,303,FII(I),PCRO,PODVT,PODVO,PCDV,PCFI,POPSI,
 50  1 PCV
 303  FCRMAT(1X,8(E11.4,2X))
C END OF LCCP FCR EACH INIT. COND.
 500  IF(CATA)550,550,800
 550  WRITE CUTPUT TAPE 3,7CO
 700  FCRMAT(15H ENC OF PROGRAM)
 600  CALL EXIT
      ENC(1,0,C,0,0,0,1,0,C,1,C,0,C,C,C)
```

OPTIMUM 2-STAGE TRAJECTORY

```
MARS    H-TRAJECTORY
RMIN = 0.3670E 01    RMAX= 0.3670E 01    RIN= 0.3260E 03    RE= 0.6370E 04    PCERR= 1.0000E-04    L= 19
ROIN = 0.3670E 01    FIIN=-0.9000E 02    VIN= 0.8900E-01    VE= 0.2980E 02    ODVI = 0.5555E 05    M=  1
DROIN= 0.            DFI = 0.1000E 02    G  = 0.1080E-00    GE= 0.3990E 06    ICI  =  0            N= 10
RS   = 0.5300E 00
OPTRON      = 0.36699537E 01         OPTDVE    = 0.62581232E-01          OPTFI= 0.90712652E 00
OPTDV(KM/S)= 0.12390130E 05          OPTRO(KM)= 0.18649207E 01
```

FI INIT. DEGREES	ORB.RADIUS /RS	TOTAL DV /OPT.DV	DV AT ORB. /OPT.DV	DV AT RIN /OPT.DV	FI DEGREES	PSI DEGREES	V /VE
-0.9000E 02	0.3670E 01	0.1860E 01	0.4142E-00	0.1446E 01	0.6089E 01	0.8408E 02	0.9392E-02
-0.8000E 02	0.3670E 01	0.1834E 01	0.4142E-00	0.1420E 01	0.6078E 01	0.9394E 02	0.9410E-02
-0.7000E 02	0.3670E 01	0.1801E 01	0.4278E-00	0.1374E 01	0.3729E 01	0.1001E 03	0.1547E-01
-0.6000E 02	0.3670E 01	0.1748E 01	0.4553E-00	0.1293E 01	0.2506E 01	0.1051E 03	0.2345E-01
-0.5000E 02	0.3670E 01	0.1674E 01	0.4954E-00	0.1178E 01	0.1897E 01	0.1101E 03	0.3183E-01
-0.4000E 02	0.3670E 01	0.1579E 01	0.5499E 00	0.1029E 01	0.1534E 01	0.1152E 03	0.4079E-01
-0.3000E 02	0.3670E 01	0.1465E 01	0.6215E 00	0.8438E 00	0.1296E 01	0.1202E 03	0.5053E-01
-0.2000E 02	0.3670E 01	0.1333E 01	0.7132E 00	0.6196E 00	0.1129E 01	0.1253E 03	0.6124E-01
-1.0000E 01	0.3670E 01	0.1183E 01	0.8318E 00	0.3508E-00	0.1007E 01	0.1303E 03	0.7346E-01
0.8538E-06	0.3670E 01	0.1016E 01	0.9843E 00	0.3163E-01	0.9143E 00	0.1351E 03	0.8761E-01
0.1000E 02	0.3670E 01	0.1151E 01	0.8548E 00	0.2961E-00	0.9892E 00	-0.1302E 03	0.7569E-01
0.2000E 02	0.3670E 01	0.1301E 01	0.7293E 00	0.5718E 00	0.1108E 01	-0.1253E 03	0.6299E-01
0.3000E 02	0.3670E 01	0.1434E 01	0.6320E 00	0.8017E 00	0.1271E 01	-0.1202E 03	0.5184E-01
0.4000E 02	0.3670E 01	0.1548E 01	0.5571E 00	0.9905E 00	0.1502E 01	-0.1151E 03	0.4185E-01
0.5000E 02	0.3670E 01	0.1642E 01	0.5000E-00	0.1142E 01	0.1854E 01	-0.1101E 03	0.3266E-01
0.6000E 02	0.3670E 01	0.1716E 01	0.4579E-00	0.1258E 01	0.2445E 01	-0.1050E 03	0.2408E-01
0.7000E 02	0.3670E 01	0.1770E 01	0.4290E-00	0.1341E 01	0.3630E 01	-0.1000E 03	0.1590E-01
0.8000E 02	0.3670E 01	0.1802E 01	0.4142E-00	0.1388E 01	0.6078E 01	-0.9403E 02	0.9410E-02
0.9000E 02	0.3670E 01	0.1828E 01	0.4142E-00	0.1414E 01	0.6089E 01	-0.8394E 02	0.9392E-02

```
OPTIMUM 2-STAGE TRAJECTORY

MARS    H-TRAJECTORY
RMIN = 0.3670E 01    RMAX= 0.3670E 01    RIN= 0.3260E 03    RE= 0.6370E 04    PCERR= 1.0000E-04    L= 21
ROIN = 0.3670E 01    FIIN=-0.1000E 02    VIN= 0.8900E-01    VE= 0.2980E 02    ODVI = 0.5555E 05    M=  1
DROIN= 0.            DFI = 0.1000E 01    G  = 0.1080E-00    GE= 0.3990E 06    ICI  =  0            N= 10
RS   = 0.5300E 00
OPTRON       = 0.36699537E 01             OPTDVE    = 0.62581232E-01          OPTFI= 0.90712652E 00
OPTDV(KM/S)= 0.12390130E 05               OPTRO(KM)= 0.18649207E 01
```

FI INIT. DEGREES	ORB.RADIUS /RS	TOTAL DV /OPT.DV	DV AT ORB. /OPT.DV	DV AT RIN /OPT.DV	FI DEGREES	PSI DEGREES	V /VE
-0.1000E 02	0.3670E 01	0.1183E 01	0.8318E 00	0.3508E-00	0.1007E 01	0.1303E 03	0.7346E-01
-0.9000E 01	0.3670E 01	0.1167E 01	0.8446E 00	0.3220E-00	0.9967E 00	0.1309E 03	0.7471E-01
-0.8000E 01	0.3670E 01	0.1151E 01	0.8594E 00	0.2911E-00	0.9859E 00	0.1313E 03	0.7613E-01
-0.7000E 01	0.3670E 01	0.1134E 01	0.8732E 00	0.2610E-00	0.9764E 00	0.1319E 03	0.7744E-01
-0.6000E 01	0.3670E 01	0.1118E 01	0.8883E 00	0.2295E-00	0.9665E 00	0.1322E 03	0.7887E-01
-0.5000E 01	0.3670E 01	0.1101E 01	0.9038E 00	0.1975E-00	0.9569E 00	0.1326E 03	0.8031E-01
-0.4000E 01	0.3670E 01	0.1084E 01	0.9186E 00	0.1659E-00	0.9482E 00	0.1333E 03	0.8168E-01
-0.3000E 01	0.3670E 01	0.1068E 01	0.9343E 00	0.1332E-00	0.9394E 00	0.1338E 03	0.8312E-01
-0.2000E 01	0.3670E 01	0.1050E 01	0.9508E 00	0.9974E-01	0.9307E 00	0.1341E 03	0.8461E-01
-1.0000E 00	0.3670E 01	0.1033E 01	0.9672E 00	0.6609E-01	0.9224E 00	0.1347E 03	0.8609E-01
0.3202E-06	0.3670E 01	0.1016E 01	0.9843E 00	0.3163E-01	0.9143E 00	0.1351E 03	0.8761E-01
0.1000E 01	0.3670E 01	0.1002E 01	0.9984E 00	0.3248E-02	0.9079E 00	-0.1343E 03	0.8886E-01
0.2000E 01	0.3670E 01	0.1019E 01	0.9803E 00	0.3851E-01	0.9161E 00	-0.1348E 03	0.8726E-01
0.3000E 01	0.3670E 01	0.1036E 01	0.9632E 00	0.7266E-01	0.9244E 00	-0.1339E 03.	0.8573E-01
0.4000E 01	0.3670E 01	0.1053E 01	0.9468E 00	0.1060E-00	0.9327E 00	-0.1332E 03	0.8425E-01
0.5000E 01	0.3670E 01	0.1070E 01	0.9304E 00	0.1392E-00	0.9416E 00	-0.1327E 03	0.8276E-01
0.6000E 01	0.3670E 01	0.1086E 01	0.9146E 00	0.1715E-00	0.9505E 00	-0.1322E 03	0.8131E-01
0.7000E 01	0.3670E 01	0.1103E 01	0.8988E 00	0.2038E-00	0.9599E 00	-0.1318E 03	0.7985E-01
0.8000E 01	0.3670E 01	0.1119E 01	0.8837E 00	0.2351E-00	0.9694E 00	-0.1313E 03	0.7844E-01
0.9000E 01	0.3670E 01	0.1135E 01	0.8693E 00	0.2657E-00	0.9791E 00	-0.1307E 03	0.7707E-01
0.1000E 02	0.3670E 01	0.1151E 01	0.8548E 00	0.2961E-00	0.9892E 00	-0.1302E 03	0.7569E-01

OPTIMUM 2-STAGE TRAJECTORY

```
MARS    A-TRAJECTORY
RMIN = 0.1100E 01    RMAX= 0.6100E 01    RIN= 0.3260E 03    RE= 0.6370E 04    PCERR= 1.0000E-04    L= 21
ROIN = 0.1100E 01    FIIN=-0.1000E 02    VIN= 0.2290E-00    VE= 0.2980E 02    ODVI = 0.5555E 05    M= 10
DROIN= 0.5000E 00    DFI = 0.1000E 01    G  = 0.1080E-00    GE= 0.3990E 06    ICI  =  0            N= 10
RS   = 0.5300E 00
OPTRON      = 0.54908393E 00                 OPTDVE   = 0.16179125E-00             OPTFI= 0.13636211E-00
OPTDV(KM/S)= 0.18537622E 04                  OPTRU(KM)= 0.48213793E 01
```

FI INIT. DEGREES	ORB.RADIUS /RS	TOTAL DV /OPT.DV	DV AT ORB. /OPT.DV	DV AT RIN /OPT.DV	FI DEGREES	PSI DEGREES	V /VE
-0.1000E 02	0.1100E 01	0.1165E 01	0.7877E 00	0.3770E-00	0.2597E-00	0.1383E 03	0.1800E-00
-0.9000E 01	0.1100E 01	0.1152E 01	0.8072E 00	0.3444E-00	0.2570E-00	0.1389E 03	0.1842E-00
-0.8000E 01	0.1100E 01	0.1138E 01	0.8264E 00	0.3120E-00	0.2546E-00	0.1396E 03	0.1883E-00
-0.7000E 01	0.1100E 01	0.1125E 01	0.8472E 00	0.2779E-00	0.2522E-00	0.1402E 03	0.1927E-00
-0.6000E 01	0.1100E 01	0.1112E 01	0.8692E 00	0.2425E-00	0.2497E-00	0.1408E 03	0.1973E-00
-0.5000E 01	0.1100E 01	0.1098E 01	0.8912E 00	0.2069E-00	0.2475E-00	0.1415E 03	0.2019E-00
-0.4000E 01	0.1100E 01	0.1084E 01	0.9148E 00	0.1696E-00	0.2452E-00	0.1421E 03	0.2068E-00
-0.3000E 01	0.1100E 01	0.1071E 01	0.9384E 00	0.1322E-00	0.2431E-00	0.1429E 03	0.2116E-00
-0.2000E 01	0.1100E 01	0.1057E 01	0.9645E 00	0.9214E-01	0.2410E-00	0.1433E 03	0.2169E-00
-1.0000E 00	0.1100E 01	0.1043E 01	0.9906E 00	0.5202E-01	0.2390E-00	0.1442E 03	0.2221E-00
0.3202E-06	0.1100E 01	0.1028E 01	0.1018E 01	0.1059E-01	0.2370E-00	0.1467E 03	0.2276E-00
0.1000E 01	0.1100E 01	0.1036E 01	0.1004E 01	0.3225E-01	0.2380E-00	-0.1440E 03	0.2247E-00
0.2000E 01	0.1100E 01	0.1050E 01	0.9767E 00	0.7319E-01	0.2400E-00	-0.1433E 03	0.2194E-00
0.3000E 01	0.1100E 01	0.1064E 01	0.9445E 00	0.1194E-00	0.2426E-00	-0.1450E 03	0.2129E-00
0.4000E 01	0.1100E 01	0.1078E 01	0.9254E 00	0.1523E-00	0.2443E-00	-0.1422E 03	0.2090E-00
0.5000E 01	0.1100E 01	0.1091E 01	0.9038E 00	0.1876E-00	0.2463E-00	-0.1410E 03	0.2045E-00
0.6000E 01	0.1100E 01	0.1105E 01	0.8789E 00	0.2260E-00	0.2487E-00	-0.1409E 03	0.1994E-00
0.7000E 01	0.1100E 01	0.1118E 01	0.8569E 00	0.2614E-00	0.2511E-00	-0.1402E 03	0.1948E-00
0.8000E 01	0.1100E 01	0.1132E 01	0.8358E 00	0.2959E-00	0.2535E-00	-0.1396E 03	0.1903E-00
0.9000E 01	0.1100E 01	0.1145E 01	0.8182E 00	0.3266E-00	0.2556E-00	-0.1385E 03	0.1866E-00
0.1000E 02	0.1100E 01	0.1158E 01	0.7966E 00	0.3613E-00	0.2584E-00	-0.1382E 03	0.1819E-00

OPTIMUM 2-STAGE TRAJECTORY

```
MARS   A-TRAJECTORY
RMIN = 0.1100E 01    RMAX= 0.6100E 01    RIN= 0.3260E 03    RE= 0.6370E 04    PCERR= 1.0000E-04    L= 21
ROIN = 0.1100E 01    FIIN=-0.1000E 02    VIN= 0.2290E-00    VE= 0.2980E 02    ODVI = 0.5555E 05    M= 10
DROIN= 0.5000E 00    DFI = 0.1000E 01    G  = 0.1080E-00    GE= 0.3990E 06    ICI  =  0            N= 10
RS   = 0.5300E 00
OPTRON     = 0.54908393E 00          OPTDVE    = 0.16179125E-00          OPTFI= 0.13636211E-00
OPTDV(KM/S)= 0.18537622E 04          OPTRU(KM)= 0.48213793E 01
```

FI INIT. DEGREES	ORB.RADIUS /RS	TOTAL DV /OPT.DV	DV AT ORB. /OPT.DV	DV AT RIN /OPT.DV	FI DEGREES	PSI DEGREES	V /VE
-0.1000E 02	0.1100E 01	0.1165E 01	0.7877E 00	0.3770E-00	0.2597E-00	0.1383E 03	0.1800E-00
-0.9000E 01	0.1100E 01	0.1152E 01	0.8072E 00	0.3444E-00	0.2570E-00	0.1389E 03	0.1842E-00
-0.8000E 01	0.1100E 01	0.1138E 01	0.8264E 00	0.3120E-00	0.2546E-00	0.1396E 03	0.1883E-00
-0.7000E 01	0.1100E 01	0.1125E 01	0.8472E 00	0.2779E-00	0.2522E-00	0.1402E 03	0.1927E-00
-0.6000E 01	0.1100E 01	0.1112E 01	0.8692E 00	0.2425E-00	0.2497E-00	0.1408E 03	0.1973E-00
-0.5000E 01	0.1100E 01	0.1098E 01	0.8912E 00	0.2069E-00	0.2475E-00	0.1415E 03	0.2019E-00
-0.4000E 01	0.1100E 01	0.1084E 01	0.9148E 00	0.1696E-00	0.2452E-00	0.1421E 03	0.2068E-00
-0.3000E 01	0.1100E 01	0.1071E 01	0.9384E 00	0.1322E-00	0.2431E-00	0.1429E 03	0.2116E-00
-0.2000E 01	0.1100E 01	0.1057E 01	0.9645E 00	0.9214E-01	0.2410E-00	0.1433E 03	0.2169E-00
-1.0000E 00	0.1100E 01	0.1043E 01	0.9906E 00	0.5202E-01	0.2390E-00	0.1442E 03	0.2221E-00
0.3202E-06	0.1100E 01	0.1028E 01	0.1018E 01	0.1059E-01	0.2370E-00	0.1467E 03	0.2276E-00
0.1000E 01	0.1100E 01	0.1036E 01	0.1004E 01	0.3225E-01	0.2380E-00	-0.1440E 03	0.2247E-00
0.2000E 01	0.1100E 01	0.1050E 01	0.9767E 00	0.7319E-01	0.2400E-00	-0.1433E 03	0.2194E-00
0.3000E 01	0.1100E 01	0.1064E 01	0.9445E 00	0.1194E-00	0.2426E-00	-0.1450E 03	0.2129E-00
0.4000E 01	0.1100E 01	0.1078E 01	0.9254E 00	0.1523E-00	0.2443E-00	-0.1422E 03	0.2090E-00
0.5000E 01	0.1100E 01	0.1091E 01	0.9038E 00	0.1876E-00	0.2463E-00	-0.1410E 03	0.2045E-00
0.6000E 01	0.1100E 01	0.1105E 01	0.8789E 00	0.2260E-00	0.2487E-00	-0.1409E 03	0.1994E-00
0.7000E 01	0.1100E 01	0.1118E 01	0.8569E 00	0.2614E-00	0.2511E-00	-0.1402E 03	0.1948E-00
0.8000E 01	0.1100E 01	0.1132E 01	0.8358E 00	0.2959E-00	0.2535E-00	-0.1396E 03	0.1903E-00
0.9000E 01	0.1100E 01	0.1145E 01	0.8182E 00	0.3266E-00	0.2556E-00	-0.1385E 03	0.1866E-00
0.1000E 02	0.1100E 01	0.1158E 01	0.7966E 00	0.3613E-00	0.2584E-00	-0.1382E 03	0.1819E-00

OPTIMUM 2-STAGE TRAJECTORY

MARS B-TRAJECTORY

RMIN = 0.1100E 01	RMAX= 0.6100E 01	RIN= 0.3260E 03	RE= 0.6370E 04	PCERR= 1.0000E-04	L= 21
ROIN = 0.1100E 01	FIIN=-0.1000E 02	VIN= 0.3380E-00	VE= 0.2980E 02	ODVI = 0.5555E 05	M= 10
DROIN= 0.5000E 00	DFI = 0.1000E 01	G = 0.1080E-00	GE= 0.3990E 06	ICI = 0	N= 10
RS = 0.5300E 00					

OPTRON = 0.25181452E-00 OPTDVE = 0.23890983E-00 OPTFI= 0.62565254E-01
OPTDV(KM/S)= 0.85015099E 03 OPTRO(KM)= 0.71195129E 01

FI INIT. DEGREES	ORB.RADIUS /RS	TOTAL DV /OPT.DV	DV AT ORB. /OPT.DV	DV AT RIN /OPT.DV	FI DEGREES	PSI DEGREES	V /VE
-0.1000E 02	0.1100E 01	0.1194E 01	0.7431E 00	0.4510E-00	0.2320E-00	0.1464E 03	0.2431E-00
-0.9000E 01	0.1100E 01	0.1184E 01	0.7663E 00	0.4179E-00	0.2302E-00	0.1473E 03	0.2498E-00
-0.8000E 01	0.1100E 01	0.1174E 01	0.7921E 00	0.3821E-00	0.2283E-00	0.1482E 03	0.2571E-00
-0.7000E 01	0.1100E 01	0.1164E 01	0.8218E 00	0.3424E-00	0.2263E-00	0.1489E 03	0.2654E-00
-0.6000E 01	0.1100E 01	0.1154E 01	0.8570E 00	0.2971E-00	0.2241E-00	0.1491E 03	0.2752E-00
-0.5000E 01	0.1100E 01	0.1144E 01	0.8842E 00	0.2596E-00	0.2226E-00	0.1505E 03	0.2827E-00
-0.4000E 01	0.1100E 01	0.1134E 01	0.9189E 00	0.2146E-00	0.2208E-00	0.1512E 03	0.2922E-00
-0.3000E 01	0.1100E 01	0.1123E 01	0.9546E 00	0.1686E-00	0.2192E-00	0.1521E 03	0.3019E-00
-0.2000E 01	0.1100E 01	0.1113E 01	0.9902E 00	0.1225E-00	0.2177E-00	0.1537E 03	0.3116E-00
-1.0000E 00	0.1100E 01	0.1102E 01	0.1035E 01	0.6688E-01	0.2160E-00	0.1535E 03	0.3236E-00
0.3202E-06	0.1100E 01	0.1092E 01	0.1079E 01	0.1219E-01	0.2145E-00	0.1545E 03	0.3354E-00
0.1000E 01	0.1100E 01	0.1098E 01	0.1054E 01	0.4399E-01	0.2154E-00	-0.1537E 03	0.3285E-00
0.2000E 01	0.1100E 01	0.1108E 01	0.1011E 01	0.9712E-01	0.2169E-00	-0.1528E 03	0.3172E-00
0.3000E 01	0.1100E 01	0.1119E 01	0.9714E 00	0.1472E-00	0.2185E-00	-0.1520E 03	0.3065E-00
0.4000E 01	0.1100E 01	0.1129E 01	0.9362E 00	0.1928E-00	0.2200E-00	-0.1508E 03	0.2970E-00
0.5000E 01	0.1100E 01	0.1139E 01	0.8991E 00	0.2402E-00	0.2218E-00	-0.1504E 03	0.2868E-00
0.6000E 01	0.1100E 01	0.1149E 01	0.8654E 00	0.2841E-00	0.2236E-00	-0.1497E 03	0.2776E-00
0.7000E 01	0.1100E 01	0.1160E 01	0.8372E 00	0.3225E-00	0.2253E-00	-0.1486E 03	0.2697E-00
0.8000E 01	0.1100E 01	0.1170E 01	0.8050E 00	0.3647E-00	0.2274E-00	-0.1481E 03	0.2607E-00
0.9000E 01	0.1100E 01	0.1180E 01	0.7777E 00	0.4019E-00	0.2293E-00	-0.1473E 03	0.2530E-00
0.1000E 02	0.1100E 01	0.1190E 01	0.7480E 00	0.4415E-00	0.2316E-00	-0.1468E 03	0.2446E-00

OPTIMUM 2-STAGE TRAJECTORY

MARS C-TRAJECTORY

RMIN = 0.1100E 01	RMAX= 0.6100E 01	RIN= 0.3260E 03	RE= 0.6370E 04	PCERR= 1.0000E-04	L= 21
ROIN = 0.1100E 01	FIIN=-0.1000E 02	VIN= 0.6050E 00	VE= 0.2980E 02	ODVI = 0.5555E 05	M= 10
DROIN= 0.5000E 00	DFI = 0.1000E 01	G = 0.1080E-00	GE= 0.3990E 06	ICI = 0	N= 10
RS = 0.5300E 00					

OPTRON = 0.78554799E-01 OPTDVE = 0.42774805E-00 OPTFI= 0.19522724E-01
OPTDV(KM/S)= 0.26520886E 03 OPTRO(KM)= 0.12746892E 02

FI INIT. DEGREES	ORB.RADIUS /RS	TOTAL DV /OPT.DV	DV AT ORB. /OPT.DV	DV AT RIN /OPT.DV	FI DEGREES	PSI DEGREES	V /VE
-0.1000E 02	0.1100E 01	0.1260E 01	0.6477E 00	0.6122E 00	0.2122E-00	0.1560E 03	0.3565E-00
-0.9000E 01	0.1100E 01	0.1254E 01	0.6839E 00	0.5699E 00	0.2106E-00	0.1568E 03	0.3735E-00
-0.8000E 01	0.1100E 01	0.1248E 01	0.7201E 00	0.5277E 00	0.2092E-00	0.1577E 03	0.3903E-00
-0.7000E 01	0.1100E 01	0.1242E 01	0.7563E 00	0.4853E-00	0.2080E-00	0.1588E 03	0.4070E-00
-0.6000E 01	0.1100E 01	0.1236E 01	0.8028E 00	0.4327E-00	0.2066E-00	0.1595E 03	0.4283E-00
-0.5000E 01	0.1100E 01	0.1229E 01	0.8498E 00	0.3795E-00	0.2054E-00	0.1604E 03	0.4497E-00
-0.4000E 01	0.1100E 01	0.1223E 01	0.9011E 00	0.3220E-00	0.2043E-00	0.1614E 03	0.4730E-00
-0.3000E 01	0.1100E 01	0.1217E 01	0.9548E 00	0.2620E-00	0.2033E-00	0.1626E 03	0.4972E-00
-0.2000E 01	0.1100E 01	0.1211E 01	0.1022E 01	0.1888E-00	0.2022E-00	0.1635E 03	0.5272E 00
-1.0000E 00	0.1100E 01	0.1204E 01	0.1097E 01	0.1070E-00	0.2012E-00	0.1641E 03	0.5609E 00
0.3202E-06	0.1100E 01	0.1198E 01	0.1179E 01	0.1921E-01	0.2003E-00	0.1653E 03	0.5971E 00
0.1000E 01	0.1100E 01	0.1202E 01	0.1130E 01	0.7128E-01	0.2008E-00	-0.1637E 03	0.5756E 00
0.2000E 01	0.1100E 01	0.1208E 01	0.1053E 01	0.1554E-00	0.2017E-00	-0.1632E 03	0.5410E 00
0.3000E 01	0.1100E 01	0.1214E 01	0.9850E 00	0.2293E-00	0.2028E-00	-0.1623E 03	0.5107E 00
0.4000E 01	0.1100E 01	0.1221E 01	0.9246E 00	0.2959E-00	0.2038E-00	-0.1613E 03	0.4836E-00
0.5000E 01	0.1100E 01	0.1227E 01	0.8703E 00	0.3564E-00	0.2049E-00	-0.1604E 03	0.4591E-00
0.6000E 01	0.1100E 01	0.1233E 01	0.8209E 00	0.4121E-00	0.2061E-00	-0.1595E 03	0.4366E-00
0.7000E 01	0.1100E 01	0.1239E 01	0.7744E 00	0.4647E-00	0.2074E-00	-0.1587E 03	0.4153E-00
0.8000E 01	0.1100E 01	0.1245E 01	0.7352E 00	0.5100E 00	0.2087E-00	-0.1577E 03	0.3973E-00
0.9000E 01	0.1100E 01	0.1251E 01	0.6978E 00	0.5535E 00	0.2100E-00	-0.1568E 03	0.3799E-00
0.1000E 02	0.1100E 01	0.1257E 01	0.6598E 00	0.5976E 00	0.2117E-00	-0.1561E 03	0.3622E-00

OPTIMUM 2-STAGE TRAJECTORY

VENUS H-TRAJECTORY

RMIN = 0.1100E 01	RMAX= 0.1610E 02	RIN= 0.1780E 03	RE= 0.6370E 04	PCERR= 1.0000E-04	L= 19
ROIN = 0.1100E 01	FIIN=-0.9000E 02	VIN= 0.9300E-01	VE= 0.2980E 02	ODVI = 0.5555E 05	M= 10
DROIN= 0.1500E 01	DFI = 0.1000E 02	G = 0.8150E 00	GE= 0.3990E 06	ICI = 0	N= 10
RS = 0.9700E 00					

OPTRON = 0.14847188E 02 OPTDVE = 0.63178787E-01 OPTFI= 0.65072761E 01
OPTDV(KM/S)= 0.91739290E 05 OPTRO(KM)= 0.18827278E 01

FI INIT. DEGREES	ORB.RADIUS /RS	TOTAL DV /OPT.DV	DV AT ORB. /OPT.DV	DV AT RIN /OPT.DV	FI DEGREES	PSI DEGREES	V /VE
-0.9000E 02	0.1460E 02	0.2054E 01	0.4177E-00	0.1636E 01	0.1664E 02	0.7616E 02	0.2581E-01
-0.8000E 02	0.1460E 02	0.1990E 01	0.4177E-00	0.1572E 01	0.1664E 02	0.8505E 02	0.2581E-01
-0.7000E 02	0.1460E 02	0.1922E 01	0.4177E-00	0.1504E 01	0.1664E 02	0.9427E 02	0.2581E-01
-0.6000E 02	0.1460E 02	0.1852E 01	0.4177E-00	0.1434E 01	0.1664E 02	0.1039E 03	0.2581E-01
-0.5000E 02	0.1460E 02	0.1776E 01	0.4430E-00	0.1333E 01	0.1408E 02	0.1107E 03	0.3092E-01
-0.4000E 02	0.1460E 02	0.1681E 01	0.4922E-00	0.1189E 01	0.1145E 02	0.1159E 03	0.3919E-01
-0.3000E 02	0.1460E 02	0.1567E 01	0.5566E 00	0.1010E 01	0.9685E 01	0.1212E 03	0.4821E-01
-0.2000E 02	0.1460E 02	0.1434E 01	0.6397E 00	0.7939E 00	0.8435E 01	0.1264E 03	0.5823E-01
-1.0000E 01	0.1460E 02	0.1283E 01	0.7478E 00	0.5351E 00	0.7502E 01	0.1317E 03	0.6970E-01
0.8538E-06	0.1010E 02	0.1107E 01	0.9435E 00	0.1633E-00	0.5126E 01	0.1315E 03	0.8651E-01
0.1000E 02	0.1460E 02	0.1058E 01	0.9286E 00	0.1294E-00	0.6645E 01	-0.1316E 03	0.8674E-01
0.2000E 02	0.1460E 02	0.1209E 01	0.7637E 00	0.4450E-00	0.7401E 01	-0.1264E 03	0.7129E-01
0.3000E 02	0.1460E 02	0.1342E 01	0.6397E 00	0.7021E 00	0.8435E 01	-0.1212E 03	0.5823E-01
0.4000E 02	0.1460E 02	0.1456E 01	0.5455E 00	0.9106E 00	0.9917E 01	-0.1160E 03	0.4676E-01
0.5000E 02	0.1460E 02	0.1551E 01	0.4755E-00	0.1075E 01	0.1214E 02	-0.1107E 03	0.3658E-01
0.6000E 02	0.1460E 02	0.1625E 01	0.4243E-00	0.1201E 01	0.1583E 02	-0.1055E 03	0.2722E-01
0.7000E 02	0.1460E 02	0.1689E 01	0.4177E-00	0.1271E 01	0.1664E 02	-0.9506E 02	0.2581E-01
0.8000E 02	0.1460E 02	0.1757E 01	0.4177E-00	0.1340E 01	0.1664E 02	-0.8418E 02	0.2581E-01
0.9000E 02	0.1460E 02	0.1828E 01	0.4177E-00	0.1410E 01	0.1664E 02	-0.7389E 02	0.2581E-01

OPTIMUM 2-STAGE TRAJECTORY

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VENUS  H-TRAJECTORY
RMIN = 0.1100E 01   RMAX= 0.1610E 02   RIN= 0.1780E 03   RE= 0.6370E 04   PCERR= 1.0000E-04   L= 21
ROIN = 0.1100E 01   FIIN=-0.1000E 02   VIN= 0.9300E-01   VE= 0.2980E 02   ODVI = 0.5555E 05   M= 10
DROIN= 0.1500E 01   DFI = 0.1000E 01   G  = 0.8150E 00   GE= 0.3990E 06   ICI  =  0           N= 10
RS   = 0.9700E 00
OPTRON      = 0.14847188E 02           OPTDVE    = 0.63178787E-01            OPTFI= 0.65072761E 01
OPTDV(KM/S)= 0.91739290E 05            OPTRO(KM)= 0.18827278E 01
```

FI INIT. DEGREES	ORB.RADIUS /RS	TOTAL DV /OPT.DV	DV AT ORB. /OPT.DV	DV AT RIN /OPT.DV	FI DEGREES	PSI DEGREES	V /VE
-0.1000E 02	0.1460E 02	0.1283E 01	0.7478E 00	0.5351E 00	0.7502E 01	0.1317E 03	0.6970E-01
-0.9000E 01	0.1310E 02	0.1267E 01	0.7827E 00	0.4840E-00	0.6815E 01	0.1308E 03	0.7238E-01
-0.8000E 01	0.1310E 02	0.1250E 01	0.7947E 00	0.4553E-00	0.6746E 01	0.1314E 03	0.7359E-01
-0.7000E 01	0.1310E 02	0.1233E 01	0.8077E 00	0.4255E-00	0.6674E 01	0.1318E 03	0.7490E-01
-0.6000E 01	0.1310E 02	0.1216E 01	0.8200E 00	0.3961E-00	0.6610E 01	0.1324E 03	0.7612E-01
-0.5000E 01	0.1160E 02	0.1199E 01	0.8562E 00	0.3424E-00	0.5958E 01	0.1312E 03	0.7884E-01
-0.4000E 01	0.1160E 02	0.1181E 01	0.8689E 00	0.3117E-00	0.5900E 01	0.1316E 03	0.8011E-01
-0.3000E 01	0.1160E 02	0.1163E 01	0.8833E 00	0.2793E-00	0.5839E 01	0.1318E 03	0.8154E-01
-0.2000E 01	0.1160E 02	0.1144E 01	0.8951E 00	0.2493E-00	0.5790E 01	0.1326E 03	0.8270E-01
-1.0000E 00	0.1160E 02	0.1126E 01	0.9091E 00	0.2169E-00	0.5736E 01	0.1330E 03	0.8406E-01
0.3202E-06	0.1010E 02	0.1107E 01	0.9435E 00	0.1633E-00	0.5126E 01	0.1315E 03	0.8651E-01
0.1000E 01	0.1010E 02	0.1087E 01	0.9565E 00	0.1310E-00	0.5081E 01	0.1320E 03	0.8780E-01
0.2000E 01	0.1010E 02	0.1068E 01	0.9702E 00	0.9782E-01	0.5036E 01	0.1322E 03	0.8914E-01
0.3000E 01	0.1010E 02	0.1048E 01	0.9835E 00	0.6482E-01	0.4994E 01	0.1328E 03	0.9043E-01
0.4000E 01	0.1010E 02	0.1028E 01	0.9974E 00	0.3105E-01	0.4952E 01	0.1330E 03	0.9178E-01
0.5000E 01	0.1010E 02	0.1012E 01	0.1009E 01	0.2908E-02	0.4919E 01	-0.1291E 03	0.9287E-01
0.6000E 01	0.1310E 02	0.1002E 01	0.9996E 00	0.2611E-02	0.5932E 01	-0.1317E 03	0.9288E-01
0.7000E 01	0.1460E 02	0.1009E 01	0.9881E 00	0.2133E-01	0.6459E 01	-0.1329E 03	0.9197E-01
0.8000E 01	0.1460E 02	0.1026E 01	0.9674E 00	0.5844E-01	0.6520E 01	-0.1329E 03	0.9016E-01
0.9000E 01	0.1460E 02	0.1042E 01	0.9476E 00	0.9435E-01	0.6582E 01	-0.1323E 03	0.8843E-01
0.1000E 02	0.1460E 02	0.1058E 01	0.9286E 00	0.1294E-00	0.6645E 01	-0.1316E 03	0.8674E-01

OPTIMUM 2-STAGE TRAJECTORY

VENUS H-TRAJECTORY

RMIN = 0.1100E 01	RMAX= 0.6100E 01	RIN= 0.1780E 03	RE= 0.6370E 04	PCERR= 1.0000E-04	L= 21
ROIN = 0.1100E 01	FIIN=-0.1000E 02	VIN= 0.9300E-01	VE= 0.2980E 02	ODVI = 0.5555E 05	M= 10
DROIN= 0.5000E 00	DFI = 0.1000E 01	G = 0.8150E 00	GE= 0.3990E 06	ICI = 0	N= 10
RS = 0.9700E 00					

OPTRON = 0.14847188E 02   OPTDVE = 0.63178787E-01   OPTFI= 0.65072761E 01
OPTDV(KM/S)= 0.91739290E 05   OPTRO(KM)= 0.18827278E 01

FI INIT. DEGREES	ORB.RADIUS /RS	TOTAL DV /OPT.DV	DV AT ORB. /OPT.DV	DV AT RIN /OPT.DV	FI DEGREES	PSI DEGREES	V /VE
-0.1000E 02	0.5600E 01	0.1353E 01	0.9639E 00	0.3889E-00	0.3715E 01	0.1199E 03	0.7951E-01
-0.9000E 01	0.5600E 01	0.1333E 01	0.9721E 00	0.3609E-00	0.3678E 01	0.1202E 03	0.8056E-01
-0.8000E 01	0.5600E 01	0.1313E 01	0.9780E 00	0.3350E-00	0.3652E 01	0.1211E 03	0.8133E-01
-0.7000E 01	0.5600E 01	0.1293E 01	0.9876E 00	0.3052E-00	0.3611E 01	0.1210E 03	0.8255E-01
-0.6000E 01	0.5600E 01	0.1272E 01	0.9960E 00	0.2765E-00	0.3577E 01	0.1212E 03	0.8360E-01
-0.5000E 01	0.5600E 01	0.1252E 01	0.1004E 01	0.2478E-00	0.3545E 01	0.1216E 03	0.8461E-01
-0.4000E 01	0.5600E 01	0.1231E 01	0.1013E 01	0.2184E-00	0.3513E 01	0.1217E 03	0.8568E-01
-0.3000E 01	0.5600E 01	0.1210E 01	0.1021E 01	0.1893E-00	0.3483E 01	0.1221E 03	0.8667E-01
-0.2000E 01	0.5600E 01	0.1189E 01	0.1031E 01	0.1585E-00	0.3448E 01	0.1216E 03	0.8786E-01
-1.0000E 00	0.5600E 01	0.1168E 01	0.1038E 01	0.1302E-00	0.3425E 01	0.1227E 03	0.8870E-01
0.3202E-06	0.5600E 01	0.1146E 01	0.1046E 01	0.1001E-00	0.3397E 01	0.1228E 03	0.8973E-01
0.1000E 01	0.5600E 01	0.1125E 01	0.1055E 01	0.7015E-01	0.3370E 01	0.1232E 03	0.9072E-01
0.2000E 01	0.5600E 01	0.1103E 01	0.1063E 01	0.3998E-01	0.3344E 01	0.1236E 03	0.9170E-01
0.3000E 01	0.5600E 01	0.1081E 01	0.1071E 01	0.9668E-02	0.3319E 01	0.1253E 03	0.9267E-01
0.4000E 01	0.5600E 01	0.1088E 01	0.1067E 01	0.2103E-01	0.3330E 01	-0.1218E 03	0.9223E-01
0.5000E 01	0.5600E 01	0.1109E 01	0.1057E 01	0.5232E-01	0.3362E 01	-0.1231E 03	0.9100E-01
0.6000E 01	0.5600E 01	0.1130E 01	0.1049E 01	0.8121E-01	0.3389E 01	-0.1209E 03	0.9001E-01
0.7000E 01	0.5600E 01	0.1150E 01	0.1039E 01	0.1112E-00	0.3420E 01	-0.1208E 03	0.8887E-01
0.8000E 01	0.5600E 01	0.1170E 01	0.1031E 01	0.1397E-00	0.3448E 01	-0.1198E 03	0.8786E-01
0.9000E 01	0.5600E 01	0.1190E 01	0.1020E 01	0.1700E-00	0.3485E 01	-0.1202E 03	0.8662E-01
0.1000E 02	0.5600E 01	0.1210E 01	0.1011E 01	0.1989E-00	0.3518E 01	-0.1198E 03	0.8550E-01

OPTIMUM 2-STAGE TRAJECTORY

VENUS D-TRAJECTORY

RMIN = 0.1100E 01	RMAX= 0.6100E 01	RIN= 0.1780E 03	RE= 0.6370E 04	PCERR= 1.0000E-04	L= 21
ROIN = 0.1100E 01	FIIN=-0.1000E 02	VIN= 0.1270E-00	VE= 0.2980E 02	UDVI = 0.5555E 05	M= 10
DROIN= 0.5000E 00	DFI = 0.1000E 01	G = 0.8150E 00	GE= 0.3990E 06	ICI = 0	N= 10
RS = 0.9700E 00					

OPTRON = 0.76651334E 01   OPTDVE = 0.87929282E-01   OPTFI= 0.34185337E 01
OPTDV(KM/S)= 0.47362092E 05   OPTRO(KM)= 0.26202926E 01

FI INIT. DEGREES	ORB.RADIUS /RS	TOTAL DV /OPT.DV	DV AT ORB. /OPT.DV	DV AT RIN /OPT.DV	FI DEGREES	PSI DEGREES	V /VE
-0.1000E 02	0.5600E 01	0.1239E 01	0.8449E 00	0.3939E-00	0.3062E 01	0.1271E 03	0.1043E-00
-0.9000E 01	0.5600E 01	0.1221E 01	0.8563E 00	0.3652E-00	0.3030E 01	0.1275E 03	0.1060E-00
-0.8000E 01	0.5600E 01	0.1204E 01	0.8677E 00	0.3363E-00	0.3000E 01	0.1280E 03	0.1077E-00
-0.7000E 01	0.5600E 01	0.1186E 01	0.8789E 00	0.3076E-00	0.2971E 01	0.1286E 03	0.1093E-00
-0.6000E 01	0.5600E 01	0.1169E 01	0.8912E 00	0.2775E-00	0.2941E 01	0.1289E 03	0.1111E-00
-0.5000E 01	0.5600E 01	0.1151E 01	0.9038E 00	0.2469E-00	0.2912E 01	0.1293E 03	0.1129E-00
-0.4000E 01	0.5600E 01	0.1133E 01	0.9159E 00	0.2167E-00	0.2886E 01	0.1299E 03	0.1146E-00
-0.3000E 01	0.5600E 01	0.1114E 01	0.9291E 00	0.1852E-00	0.2858E 01	0.1301E 03	0.1165E-00
-0.2000E 01	0.5600E 01	0.1096E 01	0.9418E 00	0.1541E-00	0.2832E 01	0.1307E 03	0.1182E-00
-1.0000E 00	0.5600E 01	0.1077E 01	0.9550E 00	0.1223E-00	0.2807E 01	0.1312E 03	0.1200E-00
0.3202E-06	0.5600E 01	0.1059E 01	0.9661E 00	0.9243E-01	0.2786E 01	0.1334E 03	0.1216E-00
0.1000E 01	0.5600E 01	0.1040E 01	0.9821E 00	0.5746E-01	0.2758E 01	0.1323E 03	0.1237E-00
0.2000E 01	0.5600E 01	0.1020E 01	0.9965E 00	0.2391E-01	0.2734E 01	0.1321E 03	0.1257E-00
0.3000E 01	0.5600E 01	0.1012E 01	0.1002E 01	0.9609E-02	0.2724E 01	-0.1310E 03	0.1264E-00
0.4000E 01	0.5600E 01	0.1030E 01	0.9872E 00	0.4291E-01	0.2749E 01	-0.1300E 03	0.1244E-00
0.5000E 01	0.5600E 01	0.1048E 01	0.9725E 00	0.7577E-01	0.2775E 01	-0.1295E 03	0.1224E-00
0.6000E 01	0.5600E 01	0.1066E 01	0.9580E 00	0.1082E-00	0.2801E 01	-0.1290E 03	0.1205E-00
0.7000E 01	0.5600E 01	0.1084E 01	0.9442E 00	0.1398E-00	0.2827E 01	-0.1284E 03	0.1186E-00
0.8000E 01	0.5600E 01	0.1102E 01	0.9303E 00	0.1712E-00	0.2855E 01	-0.1280E 03	0.1166E-00
0.9000E 01	0.5600E 01	0.1119E 01	0.9165E 00	0.2025E-00	0.2884E 01	-0.1277E 03	0.1147E-00
0.1000E 02	0.5600E 01	0.1136E 01	0.9032E 00	0.2330E-00	0.2913E 01	-0.1272E 03	0.1128E-00

OPTIMUM 2-STAGE TRAJECTORY

VENUS A-TRAJECTORY

RMIN = 0.1100E 01	RMAX= 0.6100E 01	RIN= 0.1780E 03	RE= 0.6370E 04	PCERR= 1.0000E-04	L= 21
ROIN = 0.1100E 01	FIIN=-0.1000E 02	VIN= 0.2370E-00	VE= 0.2980E 02	ODVI = 0.5555E 05	M= 10
DROIN= 0.5000E 00	DFI = 0.1000E 01	G = 0.8150E 00	GE= 0.3990E 06	ICI = 0	N= 10

RS = 0.9700E 00

OPTRON = 0.21354992E 01   OPTDVE = 0.16658799E-00   OPTFI= 0.96638009E 00

OPTDV(KM/S)= 0.13195036E 05   OPTRO(KM)= 0.49643220E 01

FI INIT. DEGREES	ORB.RADIUS /RS	TOTAL DV /OPT.DV	DV AT ORB. /OPT.DV	DV AT RIN /OPT.DV	FI DEGREES	PSI DEGREES	V /VE
-0.1000E 02	0.3100E 01	0.1179E 01	0.7905E 00	0.3880E-00	0.1434E 01	0.1348E 03	0.1879E-00
-0.9000E 01	0.2600E 01	0.1164E 01	0.8239E 00	0.3401E-00	0.1235E 01	0.1332E 03	0.1953E-00
-0.8000E 01	0.2600E 01	0.1149E 01	0.8362E 00	0.3125E-00	0.1225E 01	0.1344E 03	0.1983E-00
-0.7000E 01	0.2600E 01	0.1133E 01	0.8549E 00	0.2784E-00	0.1210E 01	0.1343E 03	0.2029E-00
-0.6000E 01	0.2600E 01	0.1118E 01	0.8710E 00	0.2466E-00	0.1199E 01	0.1349E 03	0.2067E-00
-0.5000E 01	0.2600E 01	0.1102E 01	0.8879E 00	0.2140E-00	0.1187E 01	0.1354E 03	0.2107E-00
-0.4000E 01	0.2100E 01	0.1086E 01	0.9187E 00	0.1670E-00	0.9980E 00	0.1331E 03	0.2175E-00
-0.3000E 01	0.2100E 01	0.1069E 01	0.9344E 00	0.1343E-00	0.9886E 00	0.1335E 03	0.2213E-00
-0.2000E 01	0.2100E 01	0.1052E 01	0.9501E 00	0.1015E-00	0.9798E 00	0.1342E 03	0.2251E-00
-1.0000E 00	0.2100E 01	0.1034E 01	0.9664E 00	0.6783E-01	0.9710E 00	0.1348E 03	0.2290E-00
0.3202E-06	0.2100E 01	0.1017E 01	0.9834E 00	0.3338E-01	0.9623E 00	0.1353E 03	0.2331E-00
0.1000E 01	0.2100E 01	0.1001E 01	0.9992E 00	0.1595E-02	0.9547E 00	-0.1342E 03	0.2368E-00
0.2000E 01	0.2600E 01	0.1017E 01	0.9843E 00	0.3232E-01	0.1132E 01	-0.1370E 03	0.2330E-00
0.3000E 01	0.2600E 01	0.1033E 01	0.9646E 00	0.6821E-01	0.1142E 01	-0.1363E 03	0.2285E-00
0.4000E 01	0.2600E 01	0.1049E 01	0.9449E 00	0.1039E-00	0.1152E 01	-0.1360E 03	0.2240E-00
0.5000E 01	0.3100E 01	0.1065E 01	0.9254E 00	0.1393E-00	0.1333E 01	-0.1379E 03	0.2190E-00
0.6000E 01	0.3100E 01	0.1080E 01	0.9064E 00	0.1732E-00	0.1344E 01	-0.1369E 03	0.2147E-00
0.7000E 01	0.3100E 01	0.1094E 01	0.8859E 00	0.2085E-00	0.1358E 01	-0.1365E 03	0.2101E-00
0.8000E 01	0.3600E 01	0.1109E 01	0.8635E 00	0.2455E-00	0.1543E 01	-0.1378E 03	0.2045E-00
0.9000E 01	0.3600E 01	0.1123E 01	0.8432E 00	0.2797E-00	0.1558E 01	-0.1372E 03	0.1999E-00
0.1000E 02	0.3600E 01	0.1137E 01	0.8225E 00	0.3141E-00	0.1575E 01	-0.1369E 03	0.1953E-00

OPTIMUM 2-STAGE TRAJECTORY

VENUS C-TRAJECTORY

RMIN = 0.1100E 01	RMAX= 0.6100E 01	RIN= 0.1780E 03	RE= 0.6370E 04	PCERR= 1.0000E-04	L= 21
ROIN = 0.1100E 01	FIIN=-0.1000E 02	VIN= 0.4430E-00	VE= 0.2980E 02	ODVI = 0.5555E 05	M= 10
DROIN= 0.5000E 00	DFI = 0.1000E 01	G = 0.8150E 00	GE= 0.3990E 06	ICI = 0	N= 10
RS = 0.9700E 00					
OPTRON = 0.60601788E 00		OPTDVE = 0.31271641E-00		OPTFI= 0.27540174E-00	
OPTDV(KM/S)= 0.37445238E 04		OPTRO(KM)= 0.93189491E 01			

FI INIT. DEGREES	ORB.RADIUS /RS	TOTAL DV /OPT.DV	DV AT ORB. /OPT.DV	DV AT RIN /OPT.DV	FI DEGREES	PSI DEGREES	V /VE
-0.1000E 02	0.1100E 01	0.1166E 01	0.7898E 00	0.3762E-00	0.4848E-00	0.1372E 03	0.3499E-00
-0.9000E 01	0.1100E 01	0.1153E 01	0.8081E 00	0.3445E-00	0.4799E-00	0.1378E 03	0.3577E-00
-0.8000E 01	0.1100E 01	0.1139E 01	0.8267E 00	0.3123E-00	0.4752E-00	0.1385E 03	0.3656E-00
-0.7000E 01	0.1100E 01	0.1125E 01	0.8469E 00	0.2783E-00	0.4705E-00	0.1390E 03	0.3740E-00
-0.6000E 01	0.1100E 01	0.1111E 01	0.8667E 00	0.2446E-00	0.4661E-00	0.1398E 03	0.3822E-00
-0.5000E 01	0.1100E 01	0.1097E 01	0.8881E 00	0.2092E-00	0.4617E-00	0.1403E 03	0.3910F-00
-0.4000E 01	0.1100E 01	0.1083E 01	0.9139E 00	0.1694E-00	0.4568E-00	0.1399E 03	0.4014E-00
-0.3000E 01	0.1100E 01	0.1069E 01	0.9325E 00	0.1364E-00	0.4535E-00	0.1417E 03	0.4089E-00
-0.2000E 01	0.1100E 01	0.1055E 01	0.9563E 00	0.9829E-01	0.4495E-00	0.1424E 03	0.4184E-00
-1.0000E 00	0.1100E 01	0.1040E 01	0.9813E 00	0.5881E-01	0.4456E-00	0.1430E 03	0.4283F-00
0.3202E-06	0.1100E 01	0.1025E 01	0.1007E 01	0.1842E-01	0.4419E-00	0.1441E 03	0.4383E-00
0.1000E 01	0.1100E 01	0.1027E 01	0.1004E 01	0.2329E-01	0.4423E-00	-0.1432E 03	0.4371E-00
0.2000E 01	0.1100E 01	0.1042E 01	0.9773E 00	0.6435E-01	0.4462E-00	-0.1429E 03	0.4267E-00
0.3000E 01	0.1100E 01	0.1056E 01	0.9535E 00	0.1025E-00	0.4500E-00	-0.1416E 03	0.4173E-00
0.4000E 01	0.1100E 01	0.1070E 01	0.9297E 00	0.1405E-00	0.4540E-00	-0.1410E 03	0.4078E-00
0.5000E 01	0.1100E 01	0.1084E 01	0.9060E 00	0.1785E-00	0.4583E-00	-0.1406E 03	0.3982E-00
0.6000E 01	0.1100E 01	0.1098E 01	0.8849E 00	0.2135E-00	0.4624E-00	-0.1397E 03	0.3897E-00
0.7000E 01	0.1100E 01	0.1112E 01	0.8620E 00	0.2503E-00	0.4672E-00	-0.1395E 03	0.3802E-00
0.8000E 01	0.1100E 01	0.1126E 01	0.8437E 00	0.2823E-00	0.4712E-00	-0.1384E 03	0.3727E-00
0.9000E 01	0.1100E 01	0.1140E 01	0.8227E 00	0.3169E-00	0.4762E-00	-0.1380E 03	0.3639E-00
0.1000E 02	0.1100E 01	0.1153E 01	0.8049E 00	0.3482E-00	0.4807E-00	-0.1372E 03	0.3564E-00

Program 8

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 2FUNK  CPTIMUM TRAJECTORY FOR RANGE OF ORBITS

C      MAIN PRCGRAM
 1000 DIMENSICN HEAD(12)
 2000 READ INPUT TAPE 2,2001,HEAD    ,G,VIN,RIN,RS,VERR,VRERR
 2001 FCRMAT(12A6,/6E10.0)
 3000 WRITE CUTPUT TAPE 3,3001,HEAD    ,G,VIN,RIN,RS,VERR,VRERR
 3001 FCRMAT(1H1,9X,12A6// 10X, 10HINPUT DATA/
 30011              17X,2HG=,E11.4, 5X,4HVIN=,E11.4, 5X,4HRIN=,E11.4/
 30012  16X,3HRS=,E11.4, 4X,5HVERR=,E11.4, 3X,6HVRERR=,E11.4)
C CONVERT NCRMALIZATICN LCCAL NORMAL
 1     VCSESC=399.0/6.37
 2     VCS=SCRTF(VCSESQ*G/RS)
 3     RS=RS*6370.0
 4     VIN=VIN*29.8/VCS
C CALCULATE ERRCR ANGLES
 5     DELFI=ATANF(VRERR)
 6     FIER=ATANF(VERR)
 3002 WRITE CUTPUT TAPE 3,3003,VCS,RS,VIN,FIER,DELFI
 3003 FCRMAT(// 10X, 24HLCCAL NCRMALIZATION DATA/
 30031  30X, 9HVCS(K/S)=  ,E11.4, 3X,6HRS(K)=,E11.4,/
 30032  10X,10HVIN(NCRM)=,E11.4, 3X,5HFIER=,E11.4, 3X,6HDELFI=,E11.4)
C THECRETICAL CPTIMUM TRAJECTORY
 7     VINSC=VIN**2
 8     PE2=2.0/RIN
 9     E2=VINSC-PE2
 10    RCX=2.0/E2
 11    CVX=SCRTF(E2*0.5)
 12    HX=2.0/CVX
 13    FIX=ASIN(HX/(RIN*VIN))
 14    DVXC=DVX*VCS
 15    RCXC=ROX*RS
 16    FIXC=FIX*57.29578
 3004 WRITE CUTPUT TAPE 3,3005,ROX,DVX,FIX,ROXD,DVXD,FIXD
 3005 FCRMAT(// 10X, 30HTHEORETICAL CPTIMUM TRAJECTCRY/
 30051          15X,4HRCX=,E11.4, 5X,4HCVX=,E11.4, 5X,4HFIX=,E11.4,/
 30052  12X,7HRCX(K)=,E11.4, 9HCVX(K/S)=,E11.4, 9H  FIX(D)=,E11.4)
 2002 READ INPUT TAPE 2,2003,RCR,RMAX,RMIN,RERR
 2003 FCRMAT(4E10.0)
 3006 WRITE CUTPUT TAPE 3,3007,ROR,RMAX,RMIN,RERR
 3007 FCRMAT(// 10X, 10HINPUT DATA/
 30071          15X,4HROR=,E11.4, 4X,5HRMAX=,E11.4, 4X,5HRMIN=,E11.4,/
 30072  14X,5HRERR=,E11.4)
C CHECK REFERENCE CPTIMUM AGAINST CRBITAL RANGE
 17    IF(RCR)18,18,23
 18    IF(RMAX-RCX)20,19,19
 19    IF(RCX-RMIN)22,25,25
C USE LIMIT FCR REF. OUT OF RANGE
 20    RCR=RMAX
 21    GC TC 23
```

2FUNK CPTIMUM TRAJECTCRY FOR RANGE OF CRBITS

```
 22    RCR=RMIN
 23    CALL RTRAJ(RCR,VIN,VINSC,RIN,PE2,FIIN)
 24    GC TC 261
 25    RCR=RCX
 26    FIIN=FIX
 261   FIINC=FIIN*57.29578
 3008 WRITE CUTPUT TAPE 3,3009,RCR,FIIN,FIIND
 3009 FCRMAT(// 1CX, 35HCPTIMUM REFERENCE TRAJECTORY VALUES/
 30091  15X,4HRCR=,E11.4, 4X,5HFIIN=,E11.4, 9H FIIN(D)=,E11.4)
 27    IZ=1
C CUTER ERRCR ANALYSIS
C DETERMINE ALLCWANCE LIMIT
 28    RLIM=RMAX+RERR*(RMAX-1.0)
C FINC INITIAL CCNCITIONS CUE TC MICCOURSE ERROR
 281   VISC=VINSC*(1.0+VERR**2)
 282   VI=SCRTF(VISC)
 283   FII=FIER+FIIN
 3010 WRITE CUTPUT TAPE 3,3011,RLIM,VI,FII
 3011 FCRMAT(1H1,9X,20HOUTER ERROR ANALYSIS /
 30111  14X,5HRLIM=,E11.4, 6X,3HVI=,E11.4, 5X,4HFII=,E11.4)
 29    GC TC 34
C INNER ERRCR ANALYSIS
C CETERMINE ALLCWANCE LIMIT
 30    RLIM=RMIN-RERR*(RMIN-1.0)
C FINC INITIAL CCNCITICNS CUE TC MICCOURSE ERROR
 31    FII=FIIN-FIER
 32    CELFI=(-1.0)*CELFI
 3012 WRITE CUTPUT TAPE 3,3013,RLIM,VI,FII
 3013 FCRMAT(1H1, 9X,20HINNER ERROR ANALYSIS/
 30131  14X,5HRLIM=,E11.4, 6X,3HVI=,E11.4, 5X,4HFII=,E11.4)
C DETERMINE CPTIMUM REFERENCE TRAJECTORY
 34    CALL REFCPT(VI,VISQ,FII,RIN,RMAX,RMIN,DVX,PE2,HR,ZAR, FIR,ROR,FC)
C END CF LCCPS FCR INNER AND CUTER ERROR CALCULATIONS
C DETERMINE CPTIMUM SEQUENCE OF CORRECTIONS
 40    CALL CPTSEC(RIN,ROR,HR,ZAR,RLIM,DELFI,IZ,DVX,FC)
 41    IF(IZ)2CO4,2CO4,42
 2004 REAC INPUT TAPE 2,2005,CATA
 2005 FCRMAT (E10.0)
 411   IF(CATA) 3016,3016,2000
 42    IZ=0
 43    GC TC 30
 3016 WRITE CUTPUT TAPE 3,3017
 3017 FCRMAT(/// 10X, 14HEND CF PRCGRAM)
 44    CALL EXIT
       END(1,0,0,0,C,0,1,0,0,1,0,0,C,C,C)
```

```
      SUBROUTINE RTRAJ(RO,VI,VISQ,RI,PE2,FI)
```

```
      SUBROUTINE RTRAJ(RO,VI,VISQ,RI,PE2,FI)
1     VLIM=0.0001*VI
2     VESCSQ=2.0/RO
3     VESC=SQRTF(VESCSQ)
4     VO=SQRTF(VISQ+VESCSQ)
5     CVO=(VO-VESC)/9.0
6     ZA=VISQ
7     GO TO 10
8     VO=VO-CVO
9     ZA=VO**2-VESCSQ
10    H=RO*VO
11    V=SQRTF(PE2+ZA)
12    DV=V-VI
13    IF(DV)16,20,14
14    VO2=VO
15    GO TO 8
16    IF(DV+VLIM) 17,20,20
17    CVO=0.1*CVO
18    VO=VO2
19    GO TO 8
20    FI=ASIN(H/(RI*V))
      RETURN
      END(1,0,0,0,0,0,1,0,0,1,0,0,0,0,0)
```

```
SUBROUTINE REFOPT(VI,VISQ,FII,RI,RMAX,RMIN,DVX,PE2,H,ZA,FI,RO5,F3)

C PRELIMINARY CALCULATIONS
 1      ACC=1.0E-04
 2      DRO=(RMAX-RMIN)/9.0
 3      RO=RMIN-DRO
 301    F5=9.9E+05
C START LOOP FOR EACH RADII SET
 4      F4=9.9E+05
C START LOOP FOR EACH RADIUS
 5      DO 53 J=1,10
 6      RO=RO+DRO
C       TEST FOR RO OUTSIDE RANGE
 601    IF(RMAX-RO) 54,7,602
 602    IF(RO-RMIN) 53,7,7
 7      F3=9.9E+05
 8      ICI=0
 9      VESCSQ=2.0/RO
 10     VCSQ=VESCSQ/2.0
 11     VC=SQRTF(VCSQ)
 12     VESC=SQRTF(VESCSQ)
 13     CVO=(SQRTF(VISQ+VESCSQ)-VESC)/9.0
 14     VO=VESC-0.5*CVO
C START LOOP FOR EACH VELOCITY SET
 15     F2=9.9E+05
C START LOOP FOR EACH VELOCITY
 16     DO 33 K=1,10
 17     VO=VO+CVO
C       TEST FOR NON-HYPERBOLIC PATHS
 171    IF(VO-VESC) 33,33,18
 18     DVO=VO-VC
 19     ZA=VO**2-VESCSQ
 20     H=RO*VO
 21     V=SQRTF(PE2+ZA)
 22     FI=ASIN(H/(RI*V))
 23     DFI=FI-FII
 24     VCR=V*SINF(DFI)
 25     VLG=V*COSF(DFI)
 26     DVLG=VI-VLG
 27     THETA=ATANF(VCR/DVLG)
 28     DV=ABSF(VCR/SINF(THETA))
 29     F1=DV+DVO
 30     IF(F2-F1)33,33,31
 31     F2=F1
 32     VO2=VO
 33     CONTINUE
C END OF LOOP FOR EACH VELOCITY
 34     DF=F3-F2
 35     IF(DF)38,38,36
 36     F3=F2
 37     VO3=VO2
```

SUBROUTINE REFOPT(VI,VISQ,FII,RI,RMAX,RMIN,DVX,PE2,H,ZA,FI,RO5,F3)

```
 38    DFC=ABSF(DF)-ACC
 39    IF(DFC)45,45,40
 40    IF(IC1-20)41,3001,3001
 41    IC1=IC1+1
 42    CVO=0.1*CVO
 43    VO=VO3-4.5*CVO
 44    GO TO 15
C END OF LOOP FOR EACH VELOCITY ITERATION
 3001 WRITE OUTPUT TAPE 3,3002
 3002 FORMAT(10X,6HIC1=20)
 45    IF(DRO)49,46,49
 46    F5=F3
 47    VO5=VO3
 48    GO TO 66
C CHECK FOR FIXED RO
 49    IF(F4-F3)53,53,50
 50    F4=F3
 51    VO4=VO3
 52    RO4=RO
 53    CONTINUE
C END OF LOOP FOR EACH RADIUS
 54    DF=F5-F4
 55    IF(DF)59,59,56
 56    F5=F4
 57    VO5=VO4
 58    RO5=RO4
 59    DFC=ABSF(DF)-ACC
 60    IF(DFC)66,66,61
 61    IF(IC2-20)62,3003,3003
 62    IC2=IC2+1
 63    DRO=0.1*DRO
 64    RO=RO5-4.5*DRO
 641   GO TO 4
C END OF LOOP FOR EACH RADIUS ITERATION
 3003 WRITE OUTPUT TAPE 3,3004
 3004 FORMAT(10X,6HIC2=20)
C COMPUTE OUTPUT DATA
 65    VESCSQ=2.0/RO5
 66    VCSQ=VESCSQ/2.0
 67    VC=SQRTF(VCSQ)
 68    DVO=VO5-VC
 69    ZA=VO5**2-VESCSQ
 70    A=1.0/ZA
 71    H=RO5*VO5
 711   VSQ=PE2+ZA
 72    V=SQRTF(VSQ)
 73    FI=ASIN(H/(RI* V))
 74    DFI=FI-FII
```

```
SUBROUTINE REFOPT(VI,VISQ,FII,RI,RMAX,RMIN,DVX,PE2,H,ZA,FI,RO5,F3)


75    VCR=V*SINF(DFI)
76    VLG=V*COSF(DFI)
77    DVLG=VI-VLG
78    THETA=ATANF(VCR/DVLG)
79    DV=ABSF(VCR/SINF(THETA))
80    EC=RO5*ZA+1.0
81    PI=3.141592
82    CRTD=57.29578
83    IF(DVLG)84,85,85
84    THETA=THETA-PI
85    PSI=PI-THETA+FII
86    PSID=PSI*CRTD
87    THETAD=THETA*CRTD
88    FID=FI*CRTD
3005 WRITE OUTPUT TAPE 3,3006,FID,PSID,THETAD
3006 FORMAT(//10X,31HREFERENCE TRAJECTORY PARAMETERS/
30061    13X,6HFI(D)=,E11.4,2X,/HPSI(D)=,E11.4,9HTHETA(D)=,E11.4)
89    F1=F5/DVX
90    F2=DVO/DVX
91    F3=DV/DVX
3007 WRITE OUTPUT TAPE 3,3008,F1,F2,F3,RO5,A,H,EC
3008 FORMAT(15X.4HDVT=,E11.4, 5X.4HDVO=,E11.4, 6X,3HDV=,E11.4/
30081 16X,3HRO=,E11.4, 7X,2HA=,E11.4, 7X,2HH=,E11.4/16X,3HEC=,E11.4)
      RETURN
      END(1,0,0,0,0,0,1,0,0,1,0,0,0,0,0)
```

```
      SUBRCUTINE CPTSEQ(RIN,RCR,HR,ZAR,RLIM,DELFI,IZ,DVX,FC)

 1    CIMENSICN R(100),RC1(15,1C0),RCO(15),VR(1C0),FIR(100),H(100),
 1   1          PE2(100),        RC2(15,100),F1(100),F2(1C0)
 2001 REAC INPUT TAPE 2,2002,IL,NL
 2002 FCRMAT(2I10)
C N=1 ANALYSIS
 2    CALL RMATX(IL,RIN,RCR,HR,ZAR,CELFI,  R,FIR,H,VR,PE2)
 3    FCPT=9.9E+05
 301  RCC(1)= C.0
 4    IF(IZ) 3C22,3022,3020
C OUTTER ERRCR ANALYSIS
 3020 WRITE CUTPUT TAPE 3,3021
 3021 FCRMAT(1H1,1CX, 36HPOSSIBLE CRBITAL IMPULSES (DV/VCS)--,
 30211    13H CUTER ERRORS  //)
 5    DC 16 I=2,IL
 6    EC=SCRTF(H(I)**2*ZAR  +1.C)
 7    RC=(EC-1.0)/ZAR
 8    IF(RC-RLIM)9,9,30
 9    VCSC=1.0/RC
 10   VC=SCRTF(ZAR+2.0*VCSQ)
 101  VC=SCRTF(VCSC)
 11   F2(I)=VC-VC
 3013 WRITE CUTPUT TAPE 3,3014,I,F2(I),RO
 3014 FCRMAT(1CX,3HFO(,I3,2H)=,E11.4,5X,3HRO=,E11.4)
 12   RC2(1,I)=RC
 13   IF(I-IL) 16,14,16
 14   FCPT=F2(I)
 15   RCC(1)=RC2(1,I)
 16   CCNTINUE
 1602 GC TC 32
C INNER ERRCR ANALYSIS
 3022 WRITE CUTPUT TAPE 3,3023
 3023 FCRMAT(1H1,1CX, 36HPOSSIBLE CRBITAL IMPULSES (DV/VCS)--,
 30231    13H INNER ERRORS  //)
 17   DC 28 I=2,IL
 18   EC=SCRTF(H(I)**2*ZAR  +1.C)
 19   RC=(EC-1.0)/ZAR
 20   IF(RC-RLIM)3C,21,21
 21   VCSC=1.0/RC
 22   VC=SCRTF(ZAR+2.0*VCSQ)
 221  VC=SCRTF(VCSC)
 23   F2(I)=VC-VC
 3015 WRITE CUTPUT TAPE 3,3014,I,F2(I),RO
 24   RC2(1,I)=RC
 25   IF(I-IL) 28,26,28
 26   FCPT=F2(I)
 27   RCC(1)=RC2(1,I)
 28   CCNTINUE
```

```
  SLBRCUTINE CPTSEQ(RIN,ROR,HR,ZAR,RLIM,DELFI,IZ,DVX,FC)

 29    GC TC 32
 30    IF(I-2)3001,3001,32
 3001 WRITE CUTPUT TAPE 3,3002
 3002 FCRMAT(10X,15HGRID TCO COARSE )
 31    RETURN
 32    IK=I-1
 321   FCPT=FCPT/DVX +FC
 322   IF(IZ) 3C24,3024,3003
 3003 WRITE CUTPUT TAPE 3,3004,FOPT,RCO(1)
 3004 FCRMAT(1H1,9X, 27HN-CORRECTICN IMPULSE TOTALS/
 30041        1CX,  12HOUTER ERRORS  //,
 30042        11X,8HFOPT  1=,E11.4, 5X,4HRCO=,E11.4)
 323   GC TC 33
 3024 WRITE CUTPUT TAPE 3,3025,FOPT,RCO(1)
 3025 FCRMAT(1H1,9X, 27HN-CORRECTICN IMPULSE TOTALS/
 30251        10X,  12HINNER ERRORS  //,
 30252        11X,8HFOPT  1=,E11.4, 5X,4HRCO=,E11.4)
C N=2 CR MCRE ANALYSIS
 33    DC 66 N=2,NL
 34    FCPT=9.9E+05
 341   IF(N-NL) 35,342,342
 342   IE=IL
 343   GC TC 351
 35    IE=N+1
 351   N1=N-1
C START INIT-RACIUS LOOP
 36    DC 611 I=IE,IL
 37    F1(I)=9.9E+05
 38    I1=I-1
C START CORR-RACIUS LOOP
 39    DC 57 L=N,I1
 40    SFI=H(I)/(R(L)*VR(L))
 41    IF(ABSF(SFI)-1.0) 42,42,57
 42    FI=ASIN(SFI)
 43    DFI=FI-FIR(L)
 44    VCR=VR(L)*SINF(DFI)
 45    VLG=VR(L)*CCSF(DFI)
 46    DVLG=VR(L)-VLG
 47    THETA=ATANF(VCR/DVLG)
 48    DV=ABSF(VCR/SINF(THETA))
 49    F=DV+F2(L)
 50    IF(F-F1(I))51,55,55
 51    F1(I)=F
 52    DC 53 M=1,N1
 53    RC1(M,I)=RC2(M,L)
 54    RC1(N,I)=R(L)
```

```
   SUBRCUTINE CPTSEQ(RIN,RCR,HR,ZAR,RLIM,DELFI,IZ,DVX,FC)

 55    IF(N-2)56,56,57
 56    IF(L-IK) 57,611,611
 57    CCNTINUE
C END    CCRR-RACIUS LOOP
 611   CCNTINUE
C END    INIT-RADIUS LOOP
 59    FCPT=F1(IL)
 60    DC 61 M=1,N
 61    RCC(M)=RC1(M,IL)
 612   FCPT=FOPT/DVX +FC
 3005 WRITE CUTPUT TAPE 3,3006,N,FCPT ,(M,RCO(M),M=1,N)
 3006 FCRMAT(/11X,4HFCPT,I3,1H=,E11.4/
 30061  5(13X,2HRC,I3,1H=,E11.4,3X,2HRC,I3,1H=,E11.4,3X,2HRC,I3,1H=,
 30062     E11.4/))
 62    IF(N-NL)63,67,67
 63    DC 66 I=1,IL
 64    F2(I)=F1(I)
 65    DC 66 M=1,N
 66    RC2(M,I)=RC1(M,I)
C END CF LCCP FCR EACH N
 67    RETURN
       END(1,0,C,0,0,0,1,0,0,1,0,0,C,0,0)
```

```
 SUBROUTINE RMATX(IL,RIN,RR,HR,ZAR,DELFI,   R,FIR,H,VR,PE2)

1     DIMENSION    R(100),FIR(100) ,   H(10C),VR(100),PE2(100)
3000 WRITE OUTPUT TAPE 3,3001
3001 FORMAT(/// 10X,16HCORRECTION RADII/
30011          21X,1HR, 14X,3HFIR, 13X,2HVR,  14X,1HH)
2     EL=IL-2
3     ZEL=1.0/EL
4     R(2)=RR
5     RM=(RIN/R(2))**ZEL
6     DO 3002 I=2,IL
7     R(I+1)=R(I)*RM
8     PE2(I)=2.0/R(I)
9     VRSQ=ZAR+PE2(I)
10    VR(I)=SQRTF(VRSQ)
101   SFIR= HR/(R(I)*VR(I))
C  SINE-GREATER-THAN-ONE TEST
102   TEST=ABSF(SFIR) - 1.0
103   IF(TEST) 11,11,104
104   IF(TEST-.02) 105,105,3010
105   FIR(I)= 1.5707963
106   GO TO 12
11    FIR(I)=ASIN(SFIR)
12    FI=FIR(I)+DELFI
13    H(I)=HR*SINF(FI)/SINF(FIR(I))
14    GO TO 3002
3010 WRITE OUTPUT TAPE 3,3011,RM,PE2(I),ZAR
3011 FORMAT(10X,17HASIN OUT OF RANGE/
30111      10X,3HRM=,E11.4,5X,4HPE2=,E11.4,5X,4HZAR=,E11.4)
3002 WRITE OUTPUT TAPE 3,3003, I,R(I),FIR(I),VR(I),H(I)
3003 FORMAT(10X,I3,4(3X,E11.4))
15    RETURN
      END(1,0,0,0,0,0,1,0,0,1,0,0,0,0,0)
```

Mars H-Trajectory

$R_o = 3.670$

OPTIMUM MARS H-TRAJECTORY FOR ORBIT RO=3.670

CORRECTION RADII -- INNER AND OUTER ERRORS

	R	FIR	VR	H
2	0.3670E 01	0.1571E 01	0.1036E 01	0.3802E 01
3	0.3842E 01	0.1310E 01	0.1024E 01	0.3818E 01
4	0.4022E 01	0.1204E 01	0.1013E 01	0.3824E 01
5	0.4210E 01	0.1123E 01	0.1002E 01	0.3830E 01
6	0.4408E 01	0.1056E 01	0.9912E 00	0.3835E 01
7	0.4614E 01	0.9977E 00	0.9809E 00	0.3839E 01
8	0.4830E 01	0.9456E 00	0.9710E 00	0.3844E 01
9	0.5056E 01	0.8983E 00	0.9614E 00	0.3848E 01
10	0.5293E 01	0.8549E 00	0.9521E 00	0.3852E 01
11	0.5541E 01	0.8148E 00	0.9432E 00	0.3856E 01
12	0.5801E 01	0.7774E 00	0.9346E 00	0.3860E 01
13	0.6073E 01	0.7424E 00	0.9263E 00	0.3865E 01
14	0.6357E 01	0.7094E 00	0.9183E 00	0.3869E 01
15	0.6655E 01	0.6783E 00	0.9106E 00	0.3873E 01
16	0.6967E 01	0.6489E 00	0.9032E 00	0.3878E 01
17	0.7293E 01	0.6211E 00	0.8961E 00	0.3882E 01
18	0.7635E 01	0.5946E 00	0.8892E 00	0.3887E 01
19	0.7992E 01	0.5694E 00	0.8826E 00	0.3891E 01
20	0.8367E 01	0.5453E 00	0.8762E 00	0.3896E 01
21	0.8759E 01	0.5224E 00	0.8701E 00	0.3901E 01
22	0.9169E 01	0.5006E 00	0.8642E 00	0.3907E 01
23	0.9599E 01	0.4796E-00	0.8585E 00	0.3912E 01
24	0.1005E 02	0.4596E-00	0.8531E 00	0.3918E 01
25	0.1052E 02	0.4405E-00	0.8478E 00	0.3923E 01
26	0.1101E 02	0.4222E-00	0.8428E 00	0.3929E 01
27	0.1153E 02	0.4046E-00	0.8380E 00	0.3936E 01
28	0.1207E 02	0.3878E-00	0.8333E 00	0.3942E 01
29	0.1263E 02	0.3717E-00	0.8289E 00	0.3949E 01
30	0.1322E 02	0.3562E-00	0.8246E 00	0.3956E 01
31	0.1384E 02	0.3414E-00	0.8205E 00	0.3963E 01
32	0.1449E 02	0.3272E-00	0.8165E 00	0.3970E 01
33	0.1517E 02	0.3135E-00	0.8127E 00	0.3978E 01
34	0.1588E 02	0.3004E-00	0.8091E 00	0.3986E 01
35	0.1663E 02	0.2879E-00	0.8056E 00	0.3995E 01
36	0.1741E 02	0.2758E-00	0.8023E 00	0.4004E 01
37	0.1822E 02	0.2643E-00	0.7990E 00	0.4013E 01
38	0.1907E 02	0.2532E-00	0.7960E 00	0.4023E 01
39	0.1997E 02	0.2425E-00	0.7930E 00	0.4033E 01
40	0.2090E 02	0.2323E-00	0.7902E 00	0.4043E 01
41	0.2188E 02	0.2225E-00	0.7875E 00	0.4054E 01
42	0.2291E 02	0.2131E-00	0.7849E 00	0.4066E 01
43	0.2398E 02	0.2041E-00	0.7824E 00	0.4078E 01
44	0.2510E 02	0.1954E-00	0.7800E 00	0.4090E 01
45	0.2628E 02	0.1871E-00	0.7777E 00	0.4104E 01
46	0.2751E 02	0.1792E-00	0.7755E 00	0.4117E 01
47	0.2880E 02	0.1716E-00	0.7734E 00	0.4132E 01
48	0.3015E 02	0.1642E-00	0.7714E 00	0.4146E 01
49	0.3156E 02	0.1572E-00	0.7695E 00	0.4162E 01

OPTIMUM MARS H-TRAJECTORY FOR ORBIT   RO=3.670

	R	FIR	VR	H
50	0.3304E 02	0.1505E-00	0.7676E 00	0.4178E 01
51	0.3459E 02	0.1441E-00	0.7659E 00	0.4196E 01
52	0.3621E 02	0.1379E-00	0.7642E 00	0.4213E 01
53	0.3791E 02	0.1319E-00	0.7625E 00	0.4232E 01
54	0.3968E 02	0.1263E-00	0.7610E 00	0.4252E 01
55	0.4154E 02	0.1208E-00	0.7595E 00	0.4272E 01
56	0.4349E 02	0.1156E-00	0.7581E 00	0.4294E 01
57	0.4552E 02	0.1106E-00	0.7567E 00	0.4316E 01
58	0.4766E 02	0.1058E-00	0.7554E 00	0.4339E 01
59	0.4989E 02	0.1012E-00	0.7542E 00	0.4364E 01
60	0.5223E 02	0.9685E-01	0.7530E 00	0.4389E 01
61	0.5467E 02	0.9264E-01	0.7519E 00	0.4416E 01
62	0.5723E 02	0.8861E-01	0.7508E 00	0.4444E 01
63	0.5992E 02	0.8476E-01	0.7497E 00	0.4474E 01
64	0.6272E 02	0.8106E-01	0.7487E 00	0.4504E 01
65	0.6566E 02	0.7753E-01	0.7478E 00	0.4537E 01
66	0.6874E 02	0.7414E-01	0.7469E 00	0.4570E 01
67	0.7196E 02	0.7090E-01	0.7460E 00	0.4605E 01
68	0.7533E 02	0.6780E-01	0.7452E 00	0.4642E 01
69	0.7886E 02	0.6483E-01	0.7444E 00	0.4681E 01
70	0.8255E 02	0.6199E-01	0.7436E 00	0.4721E 01
71	0.8642E 02	0.5927E-01	0.7429E 00	0.4764E 01
72	0.9047E 02	0.5667E-01	0.7422E 00	0.4808E 01
73	0.9470E 02	0.5418E-01	0.7415E 00	0.4854E 01
74	0.9914E 02	0.5180E-01	0.7409E 00	0.4903E 01
75	0.1038E 03	0.4952E-01	0.7403E 00	0.4953E 01
76	0.1086E 03	0.4734E-01	0.7397E 00	0.5006E 01
77	0.1137E 03	0.4525E-01	0.7391E 00	0.5062E 01
78	0.1191E 03	0.4326E-01	0.7386E 00	0.5120E 01
79	0.1246E 03	0.4135E-01	0.7381E 00	0.5181E 01
80	0.1305E 03	0.3952E-01	0.7376E 00	0.5245E 01
81	0.1366E 03	0.3778E-01	0.7371E 00	0.5311E 01
82	0.1430E 03	0.3611E-01	0.7367E 00	0.5381E 01
83	0.1497E 03	0.3451E-01	0.7363E 00	0.5454E 01
84	0.1567E 03	0.3298E-01	0.7358E 00	0.5531E 01
85	0.1640E 03	0.3152E-01	0.7355E 00	0.5611E 01
86	0.1717E 03	0.3013E-01	0.7351E 00	0.5695E 01
87	0.1798E 03	0.2879E-01	0.7347E 00	0.5783E 01
88	0.1882E 03	0.2752E-01	0.7344E 00	0.5875E 01
89	0.1970E 03	0.2630E-01	0.7341E 00	0.5971E 01
90	0.2062E 03	0.2513E-01	0.7338E 00	0.6071E 01
91	0.2159E 03	0.2402E-01	0.7335E 00	0.6177E 01
92	0.2260E 03	0.2295E-01	0.7332E 00	0.6287E 01
93	0.2366E 03	0.2193E-01	0.7329E 00	0.6403E 01
94	0.2477E 03	0.2096E-01	0.7327E 00	0.6524E 01
95	0.2593E 03	0.2003E-01	0.7324E 00	0.6650E 01
96	0.2714E 03	0.1914E-01	0.7322E 00	0.6783E 01
97	0.2842E 03	0.1828E-01	0.7319E 00	0.6921E 01
98	0.2975E 03	0.1747E-01	0.7317E 00	0.7067E 01
99	0.3114E 03	0.1669E-01	0.7315E 00	0.7219E 01
100	0.3260E 03	0.1595E-01	0.7313E 00	0.7378E 01

OPTIMUM MARS H-TRAJECTORY FOR ORBIT RO=3.670

POSSIBLE ORBITAL IMPULSES (DV/VCS)-- OUTER ERRORS

FO(2)= 0.5142E 00	RO= 0.3669E 01
FO(3)= 0.5142E 00	RO= 0.3689E 01
FO(4)= 0.5142E 00	RO= 0.3698E 01
FO(5)= 0.5142E 00	RO= 0.3705E 01
FO(6)= 0.5142E 00	RO= 0.3711E 01
FO(7)= 0.5142E 00	RO= 0.3717E 01
FO(8)= 0.5142E 00	RO= 0.3723E 01
FO(9)= 0.5142E 00	RO= 0.3728E 01
FO(10)= 0.5142E 00	RO= 0.3734E 01
FO(11)= 0.5142E 00	RO= 0.3739E 01
FO(12)= 0.5142E 00	RO= 0.3744E 01
FO(13)= 0.5142E 00	RO= 0.3750E 01
FO(14)= 0.5142E 00	RO= 0.3755E 01
FO(15)= 0.5142E 00	RO= 0.3761E 01
FO(16)= 0.5142E 00	RO= 0.3767E 01
FO(17)= 0.5142E 00	RO= 0.3773E 01
FO(18)= 0.5142E 00	RO= 0.3779E 01
FO(19)= 0.5142E 00	RO= 0.3785E 01
FO(20)= 0.5142E 00	RO= 0.3791E 01
FO(21)= 0.5142E 00	RO= 0.3798E 01
FO(22)= 0.5142E 00	RO= 0.3805E 01
FO(23)= 0.5142E 00	RO= 0.3811E 01
FO(24)= 0.5142E 00	RO= 0.3819E 01
FO(25)= 0.5142E 00	RO= 0.3826E 01
FO(26)= 0.5142E 00	RO= 0.3834E 01
FO(27)= 0.5142E 00	RO= 0.3842E 01
FO(28)= 0.5142E 00	RO= 0.3850E 01
FO(29)= 0.5142E 00	RO= 0.3859E 01
FO(30)= 0.5142E 00	RO= 0.3868E 01
FO(31)= 0.5142E 00	RO= 0.3878E 01
FO(32)= 0.5142E 00	RO= 0.3887E 01
FO(33)= 0.5142E 00	RO= 0.3898E 01
FO(34)= 0.5142E 00	RO= 0.3908E 01
FO(35)= 0.5142E 00	RO= 0.3919E 01
FO(36)= 0.5142E 00	RO= 0.3931E 01

OPTIMUM MARS H-TRAJECTORY FOR ORBIT RC=3.670

POSSIBLE ORBITAL IMPULSES (DV/VCS)-- INNER ERRORS

FC(2)= 0.5142E 00	RO= 0.3669E 01
FC(3)= 0.5142E 00	RO= 0.3650E 01
FC(4)= 0.5142E 00	RO= 0.3641E 01
FC(5)= 0.5142E 00	RO= 0.3634E 01
FC(6)= 0.5142E 00	RO= 0.3628E 01
FC(7)= 0.5142E 00	RO= 0.3622E 01
FC(8)= 0.5142E 00	RO= 0.3616E 01
FC(9)= 0.5142E 00	RO= 0.3611E 01
FC(10)= 0.5142E 00	RO= 0.3605E 01
FC(11)= 0.5142E 00	RO= 0.3600E 01
FC(12)= 0.5142E 00	RO= 0.3595E 01
FC(13)= 0.5142E 00	RO= 0.3589E 01
FC(14)= 0.5143E 00	RO= 0.3584E 01
FC(15)= 0.5143E 00	RO= 0.3578E 01
FC(16)= 0.5143E 00	RO= 0.3572E 01
FC(17)= 0.5143E 00	RO= 0.3566E 01
FC(18)= 0.5143E 00	RO= 0.3561E 01
FC(19)= 0.5143E 00	RO= 0.3554E 01
FC(20)= 0.5143E 00	RO= 0.3548E 01
FC(21)= 0.5143E 00	RO= 0.3542E 01
FC(22)= 0.5143E 00	RO= 0.3535E 01
FC(23)= 0.5143E 00	RO= 0.3528E 01
FC(24)= 0.5143E 00	RO= 0.3521E 01
FC(25)= 0.5143E 00	RO= 0.3513E 01
FC(26)= 0.5143E 00	RO= 0.3506E 01
FC(27)= 0.5144E 00	RO= 0.3498E 01
FC(28)= 0.5144E 00	RO= 0.3489E 01
FC(29)= 0.5144E 00	RO= 0.3481E 01
FC(30)= 0.5144E 00	RO= 0.3472E 01
FC(31)= 0.5144E 00	RO= 0.3462E 01
FC(32)= 0.5144E 00	RO= 0.3453E 01
FC(33)= 0.5144E 00	RO= 0.3443E 01
FC(34)= 0.5145E 00	RO= 0.3432E 01
FC(35)= 0.5145E 00	RO= 0.3421E 01
FC(36)= 0.5145E 00	RO= 0.3410E 01

Mars H-Trajectory

Orbital Range

1.1 To 6.1

$\phi_{ER} = 0.015$

OPTIMUM MARS H-TRAJECTORY FOR ORBITAL RANGE =1.1 TO 6.1

CORRECTION RADII -- OUTER ERRORS

	R	FIR	VR	H
2	0.4239E 01	0.1351E 01	0.1025E 01	0.4255E 01
3	0.4431E 01	0.1231E 01	0.1015E 01	0.4263E 01
4	0.4632E 01	0.1145E 01	0.1005E 01	0.4269E 01
5	0.4842E 01	0.1075E 01	0.9960E 00	0.4275E 01
6	0.5061E 01	0.1014E 01	0.9869E 00	0.4280E 01
7	0.5290E 01	0.9605E 00	0.9782E 00	0.4285E 01
8	0.5530E 01	0.9120E 00	0.9698E 00	0.4290E 01
9	0.5780E 01	0.8677E 00	0.9617E 00	0.4294E 01
10	0.6042E 01	0.8268E 00	0.9539E 00	0.4299E 01
11	0.6316E 01	0.7888E 00	0.9463E 00	0.4304E 01
12	0.6602E 01	0.7533E 00	0.9390E 00	0.4308E 01
13	0.6901E 01	0.7199E 00	0.9320E 00	0.4313E 01
14	0.7214E 01	0.6884E 00	0.9253E 00	0.4318E 01
15	0.7541E 01	0.6587E 00	0.9187E 00	0.4323E 01
16	0.7883E 01	0.6306E 00	0.9125E 00	0.4327E 01
17	0.8240E 01	0.6038E 00	0.9064E 00	0.4333E 01
18	0.8613E 01	0.5784E 00	0.9006E 00	0.4338E 01
19	0.9003E 01	0.5542E 00	0.8950E 00	0.4343E 01
20	0.9411E 01	0.5312E 00	0.8896E 00	0.4349E 01
21	0.9836E 01	0.5091E 00	0.8844E 00	0.4354E 01
22	0.1028E 02	0.4881E-00	0.8794E 00	0.4360E 01
23	0.1075E 02	0.4680E-00	0.8746E 00	0.4366E 01
24	0.1124E 02	0.4487E-00	0.8700E 00	0.4372E 01
25	0.1175E 02	0.4303E-00	0.8655E 00	0.4379E 01
26	0.1228E 02	0.4127E-00	0.8613E 00	0.4386E 01
27	0.1283E 02	0.3958E-00	0.8572E 00	0.4393E 01
28	0.1342E 02	0.3795E-00	0.8532E 00	0.4400E 01
29	0.1402E 02	0.3640E-00	0.8494E 00	0.4407E 01
30	0.1466E 02	0.3491E-00	0.8458E 00	0.4415E 01
31	0.1532E 02	0.3348E-00	0.8423E 00	0.4423E 01
32	0.1602E 02	0.3211E-00	0.8389E 00	0.4432E 01
33	0.1674E 02	0.3079E-00	0.8357E 00	0.4440E 01
34	0.1750E 02	0.2953E-00	0.8326E 00	0.4449E 01
35	0.1829E 02	0.2832E-00	0.8296E 00	0.4459E 01
36	0.1912E 02	0.2716E-00	0.8267E 00	0.4469E 01
37	0.1999E 02	0.2604E-00	0.8240E 00	0.4479E 01
38	0.2090E 02	0.2497E-00	0.8213E 00	0.4490E 01
39	0.2184E 02	0.2394E-00	0.8188E 00	0.4501E 01
40	0.2283E 02	0.2295E-00	0.8164E 00	0.4513E 01
41	0.2387E 02	0.2201E-00	0.8140E 00	0.4525E 01
42	0.2495E 02	0.2110E-00	0.8118E 00	0.4537E 01
43	0.2608E 02	0.2022E-00	0.8097E 00	0.4551E 01
44	0.2726E 02	0.1938E-00	0.8076E 00	0.4564E 01
45	0.2849E 02	0.1858E-00	0.8056E 00	0.4579E 01
46	0.2979E 02	0.1781E-00	0.8038E 00	0.4594E 01
47	0.3114E 02	0.1707E-00	0.8019E 00	0.4609E 01
48	0.3255E 02	0.1636E-00	0.8002E 00	0.4626E 01
49	0.3402E 02	0.1567E-00	0.7985E 00	0.4643E 01

OPTIMUM MARS L-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

	R	FIR	VR	H
50	0.3556E 02	0.1502E-00	0.7969E 00	0.4661E 01
51	0.3717E 02	0.1439E-00	0.7954E 00	0.4679E 01
52	0.3886E 02	0.1379E-00	0.7939E 00	0.4699E 01
53	0.4062E 02	0.1321E-00	0.7925E 00	0.4719E 01
54	0.4246E 02	0.1266E-00	0.7912E 00	0.4740E 01
55	0.4438E 02	0.1213E-00	0.7899E 00	0.4762E 01
56	0.4639E 02	0.1162E-00	0.7887E 00	0.4785E 01
57	0.4850E 02	0.1113E-00	0.7875E 00	0.4810E 01
58	0.5069E 02	0.1066E-00	0.7863E 00	0.4835E 01
59	0.5299E 02	0.1021E-00	0.7853E 00	0.4861E 01
60	0.5539E 02	0.9779E-01	0.7842E 00	0.4889E 01
61	0.5790E 02	0.9365E-01	0.7832E 00	0.4918E 01
62	0.6052E 02	0.8969E-01	0.7823E 00	0.4948E 01
63	0.6327E 02	0.8590E-01	0.7813E 00	0.4979E 01
64	0.6613E 02	0.8226E-01	0.7805E 00	0.5012E 01
65	0.6913E 02	0.7877E-01	0.7796E 00	0.5046E 01
66	0.7226E 02	0.7543E-01	0.7788E 00	0.5082E 01
67	0.7553E 02	0.7222E-01	0.7780E 00	0.5120E 01
68	0.7896E 02	0.6915E-01	0.7773E 00	0.5159E 01
69	0.8253E 02	0.6621E-01	0.7766E 00	0.5200E 01
70	0.8627E 02	0.6339E-01	0.7759E 00	0.5242E 01
71	0.9018E 02	0.6069E-01	0.7753E 00	0.5287E 01
72	0.9427E 02	0.5811E-01	0.7747E 00	0.5334E 01
73	0.9854E 02	0.5563E-01	0.7741E 00	0.5383E 01
74	0.1030E 03	0.5325E-01	0.7735E 00	0.5434E 01
75	0.1077E 03	0.5098E-01	0.7730E 00	0.5487E 01
76	0.1126E 03	0.4880E-01	0.7724E 00	0.5543E 01
77	0.1177E 03	0.4671E-01	0.7719E 00	0.5601E 01
78	0.1230E 03	0.4471E-01	0.7715E 00	0.5662E 01
79	0.1286E 03	0.4280E-01	0.7710E 00	0.5726E 01
80	0.1344E 03	0.4097E-01	0.7706E 00	0.5792E 01
81	0.1405E 03	0.3921E-01	0.7701E 00	0.5862E 01
82	0.1468E 03	0.3753E-01	0.7697E 00	0.5934E 01
83	0.1535E 03	0.3592E-01	0.7694E 00	0.6010E 01
84	0.1604E 03	0.3438E-01	0.7690E 00	0.6090E 01
85	0.1677E 03	0.3290E-01	0.7686E 00	0.6173E 01
86	0.1753E 03	0.3149E-01	0.7683E 00	0.6259E 01
87	0.1832E 03	0.3014E-01	0.7680E 00	0.6350E 01
88	0.1915E 03	0.2884E-01	0.7677E 00	0.6445E 01
89	0.2002E 03	0.2760E-01	0.7674E 00	0.6544E 01
90	0.2093E 03	0.2642E-01	0.7671E 00	0.6648E 01
91	0.2188E 03	0.2528E-01	0.7668E 00	0.6756E 01
92	0.2287E 03	0.2419E-01	0.7666E 00	0.6869E 01
93	0.2391E 03	0.2315E-01	0.7663E 00	0.6987E 01
94	0.2499E 03	0.2215E-01	0.7661E 00	0.7111E 01
95	0.2612E 03	0.2120E-01	0.7659E 00	0.7240E 01
96	0.2730E 03	0.2029E-01	0.7656E 00	0.7375E 01
97	0.2854E 03	0.1941E-01	0.7654E 00	0.7516E 01
98	0.2984E 03	0.1858E-01	0.7652E 00	0.7664E 01
99	0.3119E 03	0.1778E-01	0.7650E 00	0.7818E 01
100	0.3260E 03	0.1701E-01	0.7649E 00	0.7980E 01

OPTIMUM MARS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

CORRECTION RADII -- INNER ERRORS

	R	FIR	VR	H
2	0.3461E 01	0.1417E 01	0.1065E 01	0.3635E 01
3	0.3625E 01	0.1268E 01	0.1053E 01	0.3626E 01
4	0.3798E 01	0.1172E 01	0.1041E 01	0.3620E 01
5	0.3978E 01	0.1097E 01	0.1029E 01	0.3615E 01
6	0.4167E 01	0.1033E 01	0.1018E 01	0.3610E 01
7	0.4364E 01	0.9766E 00	0.1007E 01	0.3606E 01
8	0.4572E 01	0.9260E 00	0.9971E 00	0.3602E 01
9	0.4789E 01	0.8800E 00	0.9871E 00	0.3598E 01
10	0.5016E 01	0.8376E 00	0.9775E 00	0.3594E 01
11	0.5254E 01	0.7983E 00	0.9682E 00	0.3590E 01
12	0.5504E 01	0.7616E 00	0.9593E 00	0.3586E 01
13	0.5765E 01	0.7272E 00	0.9507E 00	0.3582E 01
14	0.6039E 01	0.6949E 00	0.9423E 00	0.3577E 01
15	0.6325E 01	0.6643E 00	0.9343E 00	0.3573E 01
16	0.6625E 01	0.6353E 00	0.9266E 00	0.3569E 01
17	0.6940E 01	0.6079E 00	0.9192E 00	0.3564E 01
18	0.7269E 01	0.5818E 00	0.9121E 00	0.3560E 01
19	0.7615E 01	0.5569E 00	0.9052E 00	0.3555E 01
20	0.7976E 01	0.5332E 00	0.8986E 00	0.3550E 01
21	0.8355E 01	0.5106E 00	0.8923E 00	0.3545E 01
22	0.8751E 01	0.4891E-00	0.8862E 00	0.3540E 01
23	0.9167E 01	0.4684E-00	0.8803E 00	0.3535E 01
24	0.9602E 01	0.4487E-00	0.8747E 00	0.3529E 01
25	0.1006E 02	0.4298E-00	0.8693E 00	0.3524E 01
26	0.1054E 02	0.4118E-00	0.8641E 00	0.3518E 01
27	0.1104E 02	0.3945E-00	0.8591E 00	0.3512E 01
28	0.1156E 02	0.3779E-00	0.8543E 00	0.3505E 01
29	0.1211E 02	0.3620E-00	0.8497E 00	0.3499E 01
30	0.1268E 02	0.3468E-00	0.8453E 00	0.3492E 01
31	0.1328E 02	0.3322E-00	0.8410E 00	0.3485E 01
32	0.1392E 02	0.3182E-00	0.8370E 00	0.3477E 01
33	0.1458E 02	0.3047E-00	0.8331E 00	0.3469E 01
34	0.1527E 02	0.2919E-00	0.8293E 00	0.3461E 01
35	0.1599E 02	0.2795E-00	0.8257E 00	0.3453E 01
36	0.1675E 02	0.2677E-00	0.8223E 00	0.3444E 01
37	0.1755E 02	0.2563E-00	0.8190E 00	0.3434E 01
38	0.1838E 02	0.2454E-00	0.8159E 00	0.3425E 01
39	0.1925E 02	0.2350E-00	0.8128E 00	0.3415E 01
40	0.2017E 02	0.2250E-00	0.8099E 00	0.3404E 01
41	0.2112E 02	0.2153E-00	0.8071E 00	0.3393E 01
42	0.2213E 02	0.2061E-00	0.8045E 00	0.3382E 01
43	0.2318E 02	0.1973E-00	0.8019E 00	0.3370E 01
44	0.2428E 02	0.1888E-00	0.7995E 00	0.3357E 01
45	0.2543E 02	0.1807E-00	0.7972E 00	0.3344E 01
46	0.2664E 02	0.1729E-00	0.7949E 00	0.3330E 01
47	0.2790E 02	0.1655E-00	0.7928E 00	0.3316E 01
48	0.2923E 02	0.1583E-00	0.7907E 00	0.3301E 01
49	0.3061E 02	0.1515E-00	0.7888E 00	0.3285E 01

OPTIMUM MARS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

	R	FIR	VR	H
50	0.3207E 02	0.1449E-00	0.7869E 00	0.3268E 01
51	0.3359E 02	0.1386E-00	0.7851E 00	0.3251E 01
52	0.3519E 02	0.1326E-00	0.7834E 00	0.3233E 01
53	0.3686E 02	0.1268E-00	0.7817E 00	0.3214E 01
54	0.3861E 02	0.1213E-00	0.7801E 00	0.3195E 01
55	0.4044E 02	0.1160E-00	0.7786E 00	0.3174E 01
56	0.4236E 02	0.1109E-00	0.7772E 00	0.3152E 01
57	0.4437E 02	0.1060E-00	0.7758E 00	0.3130E 01
58	0.4647E 02	0.1014E-00	0.7745E 00	0.3106E 01
59	0.4868E 02	0.9694E-01	0.7732E 00	0.3081E 01
60	0.5099E 02	0.9268E-01	0.7720E 00	0.3055E 01
61	0.5341E 02	0.8860E-01	0.7709E 00	0.3028E 01
62	0.5595E 02	0.8470E-01	0.7698E 00	0.2999E 01
63	0.5860E 02	0.8096E-01	0.7687E 00	0.2970E 01
64	0.6139E 02	0.7739E-01	0.7677E 00	0.2938E 01
65	0.6430E 02	0.7397E-01	0.7668E 00	0.2906E 01
66	0.6735E 02	0.7069E-01	0.7658E 00	0.2871E 01
67	0.7055E 02	0.6756E-01	0.7650E 00	0.2835E 01
68	0.7390E 02	0.6457E-01	0.7641E 00	0.2798E 01
69	0.7741E 02	0.6170E-01	0.7633E 00	0.2758E 01
70	0.8108E 02	0.5896E-01	0.7625E 00	0.2717E 01
71	0.8493E 02	0.5634E-01	0.7618E 00	0.2674E 01
72	0.8896E 02	0.5383E-01	0.7611E 00	0.2629E 01
73	0.9319E 02	0.5144E-01	0.7604E 00	0.2582E 01
74	0.9761E 02	0.4915E-01	0.7598E 00	0.2532E 01
75	0.1022E 03	0.4695E-01	0.7592E 00	0.2480E 01
76	0.1071E 03	0.4486E-01	0.7586E 00	0.2426E 01
77	0.1122E 03	0.4286E-01	0.7580E 00	0.2369E 01
78	0.1175E 03	0.4094E-01	0.7575E 00	0.2309E 01
79	0.1231E 03	0.3911E-01	0.7570E 00	0.2247E 01
80	0.1289E 03	0.3736E-01	0.7565E 00	0.2181E 01
81	0.1351E 03	0.3569E-01	0.7561E 00	0.2113E 01
82	0.1415E 03	0.3409E-01	0.7556E 00	0.2041E 01
83	0.1482E 03	0.3256E-01	0.7552E 00	0.1966E 01
84	0.1552E 03	0.3110E-01	0.7548E 00	0.1887E 01
85	0.1626E 03	0.2971E-01	0.7544E 00	0.1804E 01
86	0.1703E 03	0.2838E-01	0.7540E 00	0.1718E 01
87	0.1784E 03	0.2710E-01	0.7537E 00	0.1627E 01
88	0.1869E 03	0.2589E-01	0.7533E 00	0.1532E 01
89	0.1957E 03	0.2472E-01	0.7530E 00	0.1433E 01
90	0.2050E 03	0.2361E-01	0.7527E 00	0.1329E 01
91	0.2147E 03	0.2255E-01	0.7524E 00	0.1220E 01
92	0.2249E 03	0.2154E-01	0.7521E 00	0.1106E 01
93	0.2356E 03	0.2057E-01	0.7519E 00	0.9865E 00
94	0.2468E 03	0.1964E-01	0.7516E 00	0.8613E 00
95	0.2585E 03	0.1876E-01	0.7514E 00	0.7301E 00
96	0.2708E 03	0.1791E-01	0.7511E 00	0.5928E 00
97	0.2837E 03	0.1711E-01	0.7509E 00	0.4489E-00
98	0.2971E 03	0.1634E-01	0.7507E 00	0.2981E-00
99	0.3112E 03	0.1560E-01	0.7505E 00	0.1403E-00
100	0.3260E 03	0.1490E-01	0.7503E 00	-0.2512E-01

OPTIMUM MARS H-TRAJECTORY FOR ORBITAL RANGE =1.1 TO 6.1

POSSIBLE ORBITAL IMPULSES (DV/VCS)-- INNER ERRORS

```
FO(  2)= 0.5277E 00     RO= 0.3395E 01
FO(  3)= 0.5278E 00     RO= 0.3385E 01
FO(  4)= 0.5278E 00     RO= 0.3377E 01
FO(  5)= 0.5278E 00     RO= 0.3371E 01
FO(  6)= 0.5278E 00     RO= 0.3365E 01
FO(  7)= 0.5278E 00     RO= 0.3360E 01
FO(  8)= 0.5278E 00     RO= 0.3354E 01
FO(  9)= 0.5278E 00     RO= 0.3349E 01
FO( 10)= 0.5278E 00     RO= 0.3344E 01
FO( 11)= 0.5278E 00     RO= 0.3339E 01
FO( 12)= 0.5278E 00     RO= 0.3334E 01
FO( 13)= 0.5278E 00     RO= 0.3329E 01
FO( 14)= 0.5278E 00     RO= 0.3324E 01
FO( 15)= 0.5278E 00     RO= 0.3318E 01
FO( 16)= 0.5279E 00     RO= 0.3313E 01
FO( 17)= 0.5279E 00     RO= 0.3307E 01
FO( 18)= 0.5279E 00     RO= 0.3302E 01
FO( 19)= 0.5279E 00     RO= 0.3296E 01
FO( 20)= 0.5279E 00     RO= 0.3290E 01
FO( 21)= 0.5279E 00     RO= 0.3284E 01
FO( 22)= 0.5279E 00     RO= 0.3277E 01
FO( 23)= 0.5279E 00     RO= 0.3270E 01
FO( 24)= 0.5279E 00     RO= 0.3264E 01
FO( 25)= 0.5280E 00     RO= 0.3256E 01
FO( 26)= 0.5280E 00     RO= 0.3249E 01
FO( 27)= 0.5280E 00     RO= 0.3241E 01
FO( 28)= 0.5280E 00     RO= 0.3233E 01
FO( 29)= 0.5280E 00     RO= 0.3225E 01
FO( 30)= 0.5281E 00     RO= 0.3216E 01
FO( 31)= 0.5281E 00     RO= 0.3207E 01
FO( 32)= 0.5281E 00     RO= 0.3198E 01
FO( 33)= 0.5281E 00     RO= 0.3188E 01
FO( 34)= 0.5281E 00     RO= 0.3178E 01
FO( 35)= 0.5282E 00     RO= 0.3167E 01
FO( 36)= 0.5282E 00     RO= 0.3156E 01
FO( 37)= 0.5282E 00     RO= 0.3145E 01
FO( 38)= 0.5283E 00     RO= 0.3133E 01
FO( 39)= 0.5283E 00     RO= 0.3120E 01
FO( 40)= 0.5284E 00     RO= 0.3107E 01
FO( 41)= 0.5284E 00     RO= 0.3093E 01
FO( 42)= 0.5285E 00     RO= 0.3079E 01
FO( 43)= 0.5285E 00     RO= 0.3064E 01
FO( 44)= 0.5286E 00     RO= 0.3048E 01
FO( 45)= 0.5286E 00     RO= 0.3032E 01
FO( 46)= 0.5287E 00     RO= 0.3015E 01
FO( 47)= 0.5288E 00     RO= 0.2997E 01
FO( 48)= 0.5289E 00     RO= 0.2978E 01
FO( 49)= 0.5289E 00     RO= 0.2959E 01
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OPTIMUM MARS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

FO(50)= 0.5290E 00	RO= 0.2938E 01
FO(51)= 0.5291E 00	RO= 0.2917E 01
FO(52)= 0.5293E 00	RO= 0.2894E 01
FO(53)= 0.5294E 00	RO= 0.2871E 01
FO(54)= 0.5295E 00	RO= 0.2847E 01
FO(55)= 0.5297E 00	RO= 0.2821E 01
FO(56)= 0.5298E 00	RO= 0.2794E 01
FO(57)= 0.5300E 00	RO= 0.2767E 01
FO(58)= 0.5302E 00	RO= 0.2737E 01
FO(59)= 0.5305E 00	RO= 0.2707E 01
FO(60)= 0.5307E 00	RO= 0.2675E 01
FO(61)= 0.5310E 00	RO= 0.2641E 01
FO(62)= 0.5313E 00	RO= 0.2607E 01
FO(63)= 0.5316E 00	RO= 0.2570E 01
FO(64)= 0.5320E 00	RO= 0.2532E 01
FO(65)= 0.5325E 00	RO= 0.2492E 01
FO(66)= 0.5329E 00	RO= 0.2450E 01
FO(67)= 0.5335E 00	RO= 0.2407E 01
FO(68)= 0.5341E 00	RO= 0.2361E 01
FO(69)= 0.5347E 00	RO= 0.2314E 01
FO(70)= 0.5355E 00	RO= 0.2264E 01
FO(71)= 0.5363E 00	RO= 0.2213E 01
FO(72)= 0.5373E 00	RO= 0.2158E 01
FO(73)= 0.5384E 00	RO= 0.2102E 01
FO(74)= 0.5396E 00	RO= 0.2043E 01
FO(75)= 0.5410E 00	RO= 0.1982E 01
FO(76)= 0.5427E 00	RO= 0.1918E 01
FO(77)= 0.5445E 00	RO= 0.1851E 01
FO(78)= 0.5467E 00	RO= 0.1782E 01
FO(79)= 0.5492E 00	RO= 0.1710E 01
FO(80)= 0.5521E 00	RO= 0.1635E 01
FO(81)= 0.5556E 00	RO= 0.1557E 01
FO(82)= 0.5596E 00	RO= 0.1476E 01
FO(83)= 0.5644E 00	RO= 0.1392E 01
FO(84)= 0.5701E 00	RO= 0.1305E 01
FO(85)= 0.5769E 00	RO= 0.1216E 01
FO(86)= 0.5852E 00	RO= 0.1124E 01

OPTIMUM MARS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

POSSIBLE ORBITAL IMPULSES (DV/VCS)-- OUTER ERRORS

FO(2)= 0.5390E 00	RO= 0.4125E 01
FO(3)= 0.5390E 00	RO= 0.4136E 01
FO(4)= 0.5391E 00	RO= 0.4144E 01
FO(5)= 0.5391E 00	RO= 0.4151E 01
FO(6)= 0.5391E 00	RO= 0.4157E 01
FO(7)= 0.5391E 00	RO= 0.4163E 01
FO(8)= 0.5391E 00	RO= 0.4169E 01
FO(9)= 0.5391E 00	RO= 0.4175E 01
FO(10)= 0.5392E 00	RO= 0.4181E 01
FO(11)= 0.5392E 00	RO= 0.4187E 01
FO(12)= 0.5392E 00	RO= 0.4193E 01
FO(13)= 0.5392E 00	RO= 0.4198E 01
FO(14)= 0.5392E 00	RO= 0.4204E 01
FO(15)= 0.5392E 00	RO= 0.4211E 01
FO(16)= 0.5393E 00	RO= 0.4217E 01
FO(17)= 0.5393E 00	RO= 0.4223E 01
FO(18)= 0.5393E 00	RO= 0.4230E 01
FO(19)= 0.5393E 00	RO= 0.4237E 01
FO(20)= 0.5393E 00	RO= 0.4243E 01
FO(21)= 0.5394E 00	RO= 0.4251E 01
FO(22)= 0.5394E 00	RO= 0.4258E 01
FO(23)= 0.5394E 00	RO= 0.4266E 01
FO(24)= 0.5394E 00	RO= 0.4273E 01
FO(25)= 0.5395E 00	RO= 0.4282E 01
FO(26)= 0.5395E 00	RO= 0.4290E 01
FO(27)= 0.5395E 00	RO= 0.4299E 01
FO(28)= 0.5395E 00	RO= 0.4308E 01
FO(29)= 0.5396E 00	RO= 0.4317E 01
FO(30)= 0.5396E 00	RO= 0.4327E 01
FO(31)= 0.5396E 00	RO= 0.4337E 01
FO(32)= 0.5397E 00	RO= 0.4348E 01
FO(33)= 0.5397E 00	RO= 0.4359E 01
FO(34)= 0.5397E 00	RO= 0.4370E 01
FO(35)= 0.5398E 00	RO= 0.4382E 01
FO(36)= 0.5398E 00	RO= 0.4395E 01
FO(37)= 0.5399E 00	RO= 0.4408E 01
FO(38)= 0.5399E 00	RO= 0.4421E 01
FO(39)= 0.5400E 00	RO= 0.4435E 01
FO(40)= 0.5400E 00	RO= 0.4450E 01
FO(41)= 0.5401E 00	RO= 0.4465E 01
FO(42)= 0.5401E 00	RO= 0.4481E 01
FO(43)= 0.5402E 00	RO= 0.4498E 01
FO(44)= 0.5402E 00	RO= 0.4515E 01
FO(45)= 0.5403E 00	RO= 0.4534E 01
FO(46)= 0.5404E 00	RO= 0.4553E 01
FO(47)= 0.5405E 00	RO= 0.4572E 01
FO(48)= 0.5405E 00	RO= 0.4593E 01
FO(49)= 0.5406E 00	RO= 0.4615E 01

OPTIMUM MARS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

FO(50)= 0.5407E 00	RO= 0.4637E 01
FO(51)= 0.5408E 00	RO= 0.4661E 01
FO(52)= 0.5409E 00	RO= 0.4685E 01
FO(53)= 0.5410E 00	RO= 0.4711E 01
FO(54)= 0.5411E 00	RO= 0.4738E 01
FO(55)= 0.5412E 00	RO= 0.4766E 01
FO(56)= 0.5413E 00	RO= 0.4795E 01
FO(57)= 0.5414E 00	RO= 0.4826E 01
FO(58)= 0.5416E 00	RO= 0.4858E 01
FO(59)= 0.5417E 00	RO= 0.4891E 01
FO(60)= 0.5419E 00	RO= 0.4926E 01
FO(61)= 0.5420E 00	RO= 0.4963E 01
FO(62)= 0.5422E 00	RO= 0.5001E 01
FO(63)= 0.5423E 00	RO= 0.5041E 01
FO(64)= 0.5425E 00	RO= 0.5083E 01
FO(65)= 0.5427E 00	RO= 0.5126E 01
FO(66)= 0.5429E 00	RO= 0.5172E 01
FO(67)= 0.5431E 00	RO= 0.5219E 01
FO(68)= 0.5434E 00	RO= 0.5269E 01
FO(69)= 0.5436E 00	RO= 0.5321E 01
FO(70)= 0.5439E 00	RO= 0.5376E 01
FO(71)= 0.5441E 00	RO= 0.5433E 01
FO(72)= 0.5444E 00	RO= 0.5493E 01
FO(73)= 0.5447E 00	RO= 0.5555E 01
FO(74)= 0.5450E 00	RO= 0.5620E 01
FO(75)= 0.5453E 00	RO= 0.5688E 01
FO(76)= 0.5457E 00	RO= 0.5760E 01
FO(77)= 0.5460E 00	RO= 0.5834E 01
FO(78)= 0.5464E 00	RO= 0.5912E 01
FO(79)= 0.5468E 00	RO= 0.5994E 01
FO(80)= 0.5472E 00	RO= 0.6079E 01
FO(81)= 0.5477E 00	RO= 0.6168E 01
FO(82)= 0.5481E 00	RO= 0.6261E 01
FO(83)= 0.5486E 00	RO= 0.6359E 01
FO(84)= 0.5491E 00	RO= 0.6461E 01
FO(85)= 0.5497E 00	RO= 0.6567E 01

Mars H-Trajectory

Orbital Range

1.1 to 6.1

$\phi_{EM} = .10$

OPTIMUM MARS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

CORRECTION RADII -- OUTER ERRORS

	R	FIR	VR	H
2	0.5239E 01	0.1501E 01	0.9068E 00	0.4743E 01
3	0.5464E 01	0.1308E 01	0.8981E 00	0.4758E 01
4	0.5700E 01	0.1207E 01	0.8896E 00	0.4765E 01
5	0.5945E 01	0.1130E 01	0.8814E 00	0.4772E 01
6	0.6201E 01	0.1065E 01	0.8735E 00	0.4778E 01
7	0.6468E 01	0.1009E 01	0.8659E 00	0.4783E 01
8	0.6746E 01	0.9584E 00	0.8585E 00	0.4788E 01
9	0.7037E 01	0.9126E 00	0.8513E 00	0.4793E 01
10	0.7340E 01	0.8705E 00	0.8444E 00	0.4798E 01
11	0.7656E 01	0.8315E 00	0.8377E 00	0.4803E 01
12	0.7985E 01	0.7951E 00	0.8312E 00	0.4808E 01
13	0.8329E 01	0.7610E 00	0.8250E 00	0.4813E 01
14	0.8688E 01	0.7289E 00	0.8190E 00	0.4818E 01
15	0.9062E 01	0.6986E 00	0.8131E 00	0.4823E 01
16	0.9452E 01	0.6699E 00	0.8075E 00	0.4828E 01
17	0.9859E 01	0.6426E 00	0.8021E 00	0.4833E 01
18	0.1028E 02	0.6167E 00	0.7969E 00	0.4839E 01
19	0.1073E 02	0.5920E 00	0.7918E 00	0.4844E 01
20	0.1119E 02	0.5684E 00	0.7869E 00	0.4850E 01
21	0.1167E 02	0.5459E 00	0.7822E 00	0.4855E 01
22	0.1217E 02	0.5243E 00	0.7777E 00	0.4861E 01
23	0.1270E 02	0.5037E 00	0.7733E 00	0.4867E 01
24	0.1324E 02	0.4840E-00	0.7691E 00	0.4874E 01
25	0.1381E 02	0.4650E-00	0.7650E 00	0.4880E 01
26	0.1441E 02	0.4469E-00	0.7611E 00	0.4887E 01
27	0.1503E 02	0.4295E-00	0.7574E 00	0.4894E 01
28	0.1567E 02	0.4127E-00	0.7537E 00	0.4901E 01
29	0.1635E 02	0.3967E-00	0.7502E 00	0.4908E 01
30	0.1705E 02	0.3813E-00	0.7468E 00	0.4916E 01
31	0.1779E 02	0.3664E-00	0.7436E 00	0.4924E 01
32	0.1855E 02	0.3522E-00	0.7405E 00	0.4932E 01
33	0.1935E 02	0.3385E-00	0.7375E 00	0.4940E 01
34	0.2018E 02	0.3253E-00	0.7346E 00	0.4949E 01
35	0.2105E 02	0.3127E-00	0.7318E 00	0.4958E 01
36	0.2196E 02	0.3005E-00	0.7291E 00	0.4968E 01
37	0.2291E 02	0.2888E-00	0.7265E 00	0.4978E 01
38	0.2389E 02	0.2775E-00	0.7240E 00	0.4988E 01
39	0.2492E 02	0.2667E-00	0.7216E 00	0.4999E 01
40	0.2599E 02	0.2562E-00	0.7193E 00	0.5010E 01
41	0.2711E 02	0.2462E-00	0.7171E 00	0.5021E 01
42	0.2828E 02	0.2366E-00	0.7150E 00	0.5033E 01
43	0.2950E 02	0.2273E-00	0.7130E 00	0.5046E 01
44	0.3077E 02	0.2184E-00	0.7110E 00	0.5059E 01
45	0.3209E 02	0.2098E-00	0.7091E 00	0.5072E 01
46	0.3347E 02	0.2015E-00	0.7073E 00	0.5086E 01
47	0.3491E 02	0.1936E-00	0.7055E 00	0.5101E 01
48	0.3642E 02	0.1859E-00	0.7039E 00	0.5116E 01
49	0.3799E 02	0.1786E-00	0.7022E 00	0.5132E 01

OPTIMUM MARS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

	R	FIR	VR	H
50	0.3962E 02	0.1715E-00	0.7007E 00	0.5149E 01
51	0.4133E 02	0.1647E-00	0.6992E 00	0.5166E 01
52	0.4311E 02	0.1582E-00	0.6978E 00	0.5184E 01
53	0.4496E 02	0.1519E-00	0.6964E 00	0.5203E 01
54	0.4690E 02	0.1459E-00	0.6951E 00	0.5222E 01
55	0.4892E 02	0.1401E-00	0.6938E 00	0.5242E 01
56	0.5102E 02	0.1345E-00	0.6926E 00	0.5264E 01
57	0.5322E 02	0.1291E-00	0.6914E 00	0.5286E 01
58	0.5551E 02	0.1240E-00	0.6903E 00	0.5309E 01
59	0.5790E 02	0.1190E-00	0.6892E 00	0.5333E 01
60	0.6039E 02	0.1143E-00	0.6882E 00	0.5358E 01
61	0.6299E 02	0.1097E-00	0.6872E 00	0.5384E 01
62	0.6570E 02	0.1053E-00	0.6862E 00	0.5411E 01
63	0.6853E 02	0.1011E-00	0.6853E 00	0.5439E 01
64	0.7148E 02	0.9701E-01	0.6845E 00	0.5469E 01
65	0.7456E 02	0.9311E-01	0.6836E 00	0.5500E 01
66	0.7777E 02	0.8936E-01	0.6828E 00	0.5532E 01
67	0.8112E 02	0.8576E-01	0.6820E 00	0.5565E 01
68	0.8461E 02	0.8230E-01	0.6813E 00	0.5600E 01
69	0.8825E 02	0.7898E-01	0.6806E 00	0.5636E 01
70	0.9205E 02	0.7579E-01	0.6799E 00	0.5674E 01
71	0.9602E 02	0.7273E-01	0.6792E 00	0.5714E 01
72	0.1002E 03	0.6979E-01	0.6786E 00	0.5755E 01
73	0.1045E 03	0.6696E-01	0.6780E 00	0.5798E 01
74	0.1090E 03	0.6425E-01	0.6774E 00	0.5843E 01
75	0.1137E 03	0.6165E-01	0.6768E 00	0.5890E 01
76	0.1185E 03	0.5915E-01	0.6763E 00	0.5939E 01
77	0.1236E 03	0.5675E-01	0.6758E 00	0.5990E 01
78	0.1290E 03	0.5444E-01	0.6753E 00	0.6043E 01
79	0.1345E 03	0.5223E-01	0.6748E 00	0.6098E 01
80	0.1403E 03	0.5010E-01	0.6744E 00	0.6156E 01
81	0.1464E 03	0.4807E-01	0.6739E 00	0.6216E 01
82	0.1527E 03	0.4611E-01	0.6735E 00	0.6279E 01
83	0.1592E 03	0.4423E-01	0.6731E 00	0.6344E 01
84	0.1661E 03	0.4243E-01	0.6727E 00	0.6413E 01
85	0.1732E 03	0.4070E-01	0.6723E 00	0.6484E 01
86	0.1807E 03	0.3904E-01	0.6720E 00	0.6558E 01
87	0.1885E 03	0.3745E-01	0.6716E 00	0.6636E 01
88	0.1966E 03	0.3592E-01	0.6713E 00	0.6716E 01
89	0.2050E 03	0.3445E-01	0.6710E 00	0.6801E 01
90	0.2139E 03	0.3304E-01	0.6707E 00	0.6889E 01
91	0.2231E 03	0.3169E-01	0.6704E 00	0.6980E 01
92	0.2327E 03	0.3040E-01	0.6701E 00	0.7076E 01
93	0.2427E 03	0.2915E-01	0.6699E 00	0.7176E 01
94	0.2532E 03	0.2796E-01	0.6696E 00	0.7280E 01
95	0.2641E 03	0.2681E-01	0.6694E 00	0.7388E 01
96	0.2754E 03	0.2572E-01	0.6691E 00	0.7502E 01
97	0.2873E 03	0.2466E-01	0.6689E 00	0.7620E 01
98	0.2996E 03	0.2365E-01	0.6687E 00	0.7743E 01
99	0.3125E 03	0.2268E-01	0.6685E 00	0.7871E 01
100	0.3260E 03	0.2175E-01	0.6683E 00	0.8005E 01

OPTIMUM MARS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

CORRECTION RADII -- INNER ERRORS

	R	FIR	VR	[illegible]
2	0.4017E 01	0.1427E 01	0.9817E 00	0.3894E 01
3	0.4201E 01	0.1277E 01	0.9705E 00	0.3884E 01
4	0.4394E 01	0.1182E 01	0.9597E 00	0.3878E 01
5	0.4595E 01	0.1108E 01	0.9493E 00	0.3873E 01
6	0.4806E 01	0.1044E 01	0.9392E 00	0.3868E 01
7	0.5027E 01	0.9888E 00	0.9294E 00	0.3864E 01
8	0.5257E 01	0.9389E 00	0.9199E 00	0.3859E 01
9	0.5499E 01	0.8934E 00	0.9108E 00	0.3855E 01
10	0.5751E 01	0.8516E 00	0.9020E 00	0.3851E 01
11	0.6015E 01	0.8127E 00	0.8935E 00	0.3847E 01
12	0.6291E 01	0.7764E 00	0.8853E 00	0.3842E 01
13	0.6579E 01	0.7423E 00	0.8774E 00	0.3838E 01
14	0.6881E 01	0.7103E 00	0.8698E 00	0.3834E 01
15	0.7197E 01	0.6799E 00	0.8624E 00	0.3830E 01
16	0.7527E 01	0.6512E 00	0.8553E 00	0.3825E 01
17	0.7873E 01	0.6239E 00	0.8485E 00	0.3821E 01
18	0.8234E 01	0.5980E 00	0.8419E 00	0.3816E 01
19	0.8612E 01	0.5733E 00	0.8355E 00	0.3811E 01
20	0.9007E 01	0.5497E 00	0.8294E 00	0.3807E 01
21	0.9420E 01	0.5271E 00	0.8235E 00	0.3802E 01
22	0.9852E 01	0.5056E 00	0.8178E 00	0.3796E 01
23	0.1030E 02	0.4850E-00	0.8124E 00	0.3791E 01
24	0.1078E 02	0.4653E-00	0.8071E 00	0.3785E 01
25	0.1127E 02	0.4463E-00	0.8021E 00	0.3780E 01
26	0.1179E 02	0.4282E-00	0.7972E 00	0.3774E 01
27	0.1233E 02	0.4108E-00	0.7925E 00	0.3768E 01
28	0.1290E 02	0.3942E-00	0.7880E 00	0.3761E 01
29	0.1349E 02	0.3782E-00	0.7837E 00	0.3755E 01
30	0.1411E 02	0.3628E-00	0.7795E 00	0.3748E 01
31	0.1475E 02	0.3481E-00	0.7755E 00	0.3741E 01
32	0.1543E 02	0.3339E-00	0.7717E 00	0.3733E 01
33	0.1614E 02	0.3203E-00	0.7680E 00	0.3726E 01
34	0.1686E 02	0.3073E-00	0.7644E 00	0.3718E 01
35	0.1765E 02	0.2947E-00	0.7610E 00	0.3709E 01
36	0.1846E 02	0.2827E-00	0.7578E 00	0.3701E 01
37	0.1931E 02	0.2711E-00	0.7546E 00	0.3691E 01
38	0.2020E 02	0.2600E-00	0.7516E 00	0.3682E 01
39	0.2112E 02	0.2493E-00	0.7487E 00	0.3672E 01
40	0.2209E 02	0.2391E-00	0.7459E 00	0.3662E 01
41	0.2311E 02	0.2292E-00	0.7433E 00	0.3651E 01
42	0.2417E 02	0.2198E-00	0.7407E 00	0.3640E 01
43	0.2527E 02	0.2107E-00	0.7382E 00	0.3628E 01
44	0.2643E 02	0.2020E-00	0.7359E 00	0.3616E 01
45	0.2765E 02	0.1936E-00	0.7336E 00	0.3604E 01
46	0.2892E 02	0.1856E-00	0.7315E 00	0.3590E 01
47	0.3024E 02	0.1779E-00	0.7294E 00	0.3576E 01
48	0.3163E 02	0.1704E-00	0.7274E 00	0.3562E 01
49	0.3308E 02	0.1633E-00	0.7255E 00	0.3547E 01

OPTIMUM MARS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

	R	FIR	VR	H
50	0.3460E 02	0.1565E-00	0.7237E 00	0.3531E 01
51	0.3619E 02	0.1500E-00	0.7219E 00	0.3515E 01
52	0.3785E 02	0.1437E-00	0.7202E 00	0.3497E 01
53	0.3958E 02	0.1376E-00	0.7186E 00	0.3479E 01
54	0.4140E 02	0.1318E-00	0.7171E 00	0.3461E 01
55	0.4330E 02	0.1263E-00	0.7156E 00	0.3441E 01
56	0.4529E 02	0.1210E-00	0.7142E 00	0.3421E 01
57	0.4736E 02	0.1159E-00	0.7128E 00	0.3399E 01
58	0.4954E 02	0.1110E-00	0.7115E 00	0.3377E 01
59	0.5181E 02	0.1063E-00	0.7103E 00	0.3353E 01
60	0.5419E 02	0.1017E-00	0.7091E 00	0.3329E 01
61	0.5667E 02	0.9742E-01	0.7079E 00	0.3303E 01
62	0.5927E 02	0.9328E-01	0.7068E 00	0.3276E 01
63	0.6199E 02	0.8931E-01	0.7058E 00	0.3248E 01
64	0.6484E 02	0.8551E-01	0.7048E 00	0.3219E 01
65	0.6781E 02	0.8186E-01	0.7038E 00	0.3189E 01
66	0.7092E 02	0.7836E-01	0.7029E 00	0.3157E 01
67	0.7418E 02	0.7501E-01	0.7020E 00	0.3123E 01
68	0.7758E 02	0.7180E-01	0.7012E 00	0.3088E 01
69	0.8114E 02	0.6873E-01	0.7004E 00	0.3052E 01
70	0.8486E 02	0.6578E-01	0.6996E 00	0.3014E 01
71	0.8876E 02	0.6296E-01	0.6989E 00	0.2974E 01
72	0.9283E 02	0.6025E-01	0.6982E 00	0.2932E 01
73	0.9709E 02	0.5766E-01	0.6975E 00	0.2888E 01
74	0.1015E 03	0.5518E-01	0.6968E 00	0.2842E 01
75	0.1062E 03	0.5280E-01	0.6962E 00	0.2795E 01
76	0.1111E 03	0.5053E-01	0.6956E 00	0.2745E 01
77	0.1162E 03	0.4835E-01	0.6950E 00	0.2692E 01
78	0.1215E 03	0.4626E-01	0.6945E 00	0.2638E 01
79	0.1271E 03	0.4427E-01	0.6940E 00	0.2581E 01
80	0.1329E 03	0.4235E-01	0.6935E 00	0.2521E 01
81	0.1390E 03	0.4052E-01	0.6930E 00	0.2458E 01
82	0.1454E 03	0.3877E-01	0.6926E 00	0.2393E 01
83	0.1521E 03	0.3709E-01	0.6921E 00	0.2325E 01
84	0.1590E 03	0.3548E-01	0.6917E 00	0.2253E 01
85	0.1663E 03	0.3395E-01	0.6913E 00	0.2178E 01
86	0.1740E 03	0.3247E-01	0.6909E 00	0.2100E 01
87	0.1819E 03	0.3107E-01	0.6906E 00	0.2019E 01
88	0.1903E 03	0.2972E-01	0.6902E 00	0.1933E 01
89	0.1990E 03	0.2843E-01	0.6899E 00	0.1844E 01
90	0.2082E 03	0.2719E-01	0.6896E 00	0.1750E 01
91	0.2177E 03	0.2601E-01	0.6892E 00	0.1652E 01
92	0.2277E 03	0.2488E-01	0.6890E 00	0.1550E 01
93	0.2381E 03	0.2380E-01	0.6887E 00	0.1443E 01
94	0.2491E 03	0.2276E-01	0.6884E 00	0.1331E 01
95	0.2605E 03	0.2177E-01	0.6882E 00	0.1214E 01
96	0.2724E 03	0.2082E-01	0.6879E 00	0.1092E 01
97	0.2849E 03	0.1992E-01	0.6877E 00	0.9637E 00
98	0.2980E 03	0.1905E-01	0.6874E 00	0.8298E 00
99	0.3117E 03	0.1822E-01	0.6872E 00	0.6898E 00
100	0.3260E 03	0.1742E-01	0.6870E 00	0.5434E 00

OPTIMUM MARS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

POSSIBLE ORBITAL IMPULSES (DV/VCS)-- OUTER ERRORS

```
FO(  2)= 0.4699E-00      RO= 0.5229E 01
FO(  3)= 0.4699E-00      RO= 0.5249E 01
FO(  4)= 0.4699E-00      RO= 0.5260E 01
FO(  5)= 0.4699E-00      RO= 0.5270E 01
FO(  6)= 0.4699E-00      RO= 0.5278E 01
FO(  7)= 0.4700E-00      RO= 0.5286E 01
FO(  8)= 0.4700E-00      RO= 0.5293E 01
FO(  9)= 0.4700E-00      RO= 0.5300E 01
FO( 10)= 0.4700E-00      RO= 0.5308E 01
FO( 11)= 0.4700E-00      RO= 0.5315E 01
FO( 12)= 0.4700E-00      RO= 0.5322E 01
FO( 13)= 0.4700E-00      RO= 0.5329E 01
FO( 14)= 0.4700E-00      RO= 0.5336E 01
FO( 15)= 0.4701E-00      RO= 0.5343E 01
FO( 16)= 0.4701E-00      RO= 0.5350E 01
FO( 17)= 0.4701E-00      RO= 0.5358E 01
FO( 18)= 0.4701E-00      RO= 0.5366E 01
FO( 19)= 0.4701E-00      RO= 0.5373E 01
FO( 20)= 0.4701E-00      RO= 0.5381E 01
FO( 21)= 0.4701E-00      RO= 0.5390E 01
FO( 22)= 0.4701E-00      RO= 0.5398E 01
FO( 23)= 0.4702E-00      RO= 0.5407E 01
FO( 24)= 0.4702E-00      RO= 0.5416E 01
FO( 25)= 0.4702E-00      RO= 0.5425E 01
FO( 26)= 0.4702E-00      RO= 0.5435E 01
FO( 27)= 0.4702E-00      RO= 0.5445E 01
FO( 28)= 0.4702E-00      RO= 0.5455E 01
FO( 29)= 0.4703E-00      RO= 0.5466E 01
FO( 30)= 0.4703E-00      RO= 0.5476E 01
FO( 31)= 0.4703E-00      RO= 0.5488E 01
FO( 32)= 0.4703E-00      RO= 0.5500E 01
FO( 33)= 0.4704E-00      RO= 0.5512E 01
FO( 34)= 0.4704E-00      RO= 0.5525E 01
FO( 35)= 0.4704E-00      RO= 0.5538E 01
FO( 36)= 0.4704E-00      RO= 0.5552E 01
FO( 37)= 0.4705E-00      RO= 0.5566E 01
FO( 38)= 0.4705E-00      RO= 0.5581E 01
FO( 39)= 0.4705E-00      RO= 0.5596E 01
FO( 40)= 0.4706E-00      RO= 0.5612E 01
FO( 41)= 0.4706E-00      RO= 0.5629E 01
FO( 42)= 0.4706E-00      RO= 0.5646E 01
FO( 43)= 0.4707E-00      RO= 0.5664E 01
FO( 44)= 0.4707E-00      RO= 0.5683E 01
FO( 45)= 0.4707E-00      RO= 0.5702E 01
FO( 46)= 0.4708E-00      RO= 0.5723E 01
FO( 47)= 0.4708E-00      RO= 0.5744E 01
FO( 48)= 0.4709E-00      RO= 0.5766E 01
FO( 49)= 0.4709E-00      RO= 0.5789E 01
```

OPTIMUM MARS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

FO(50)= 0.4710E-00	RO= 0.5813E 01
FO(51)= 0.4710E-00	RO= 0.5838E 01
FO(52)= 0.4711E-00	RO= 0.5864E 01
FO(53)= 0.4712E-00	RO= 0.5891E 01
FO(54)= 0.4712E-00	RO= 0.5919E 01
FO(55)= 0.4713E-00	RO= 0.5948E 01
FO(56)= 0.4714E-00	RO= 0.5979E 01
FO(57)= 0.4715E-00	RO= 0.6011E 01
FO(58)= 0.4715E-00	RO= 0.6044E 01
FO(59)= 0.4716E-00	RO= 0.6079E 01
FO(60)= 0.4717E-00	RO= 0.6115E 01
FO(61)= 0.4718E-00	RO= 0.6153E 01
FO(62)= 0.4719E-00	RO= 0.6193E 01
FO(63)= 0.4720E-00	RO= 0.6234E 01
FO(64)= 0.4721E-00	RO= 0.6277E 01
FO(65)= 0.4723E-00	RO= 0.6321E 01
FO(66)= 0.4724E-00	RO= 0.6368E 01
FO(67)= 0.4725E-00	RO= 0.6417E 01
FO(68)= 0.4727E-00	RO= 0.6468E 01
FO(69)= 0.4728E-00	RO= 0.6520E 01
FO(70)= 0.4730E-00	RO= 0.6576E 01

OPTIMUM MARS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

POSSIBLE ORBITAL IMPULSES (DV/VCS)-- INNER ERRORS

FO(2)= 0.4829E-00	RO= 0.3948E 01
FO(3)= 0.4829E-00	RO= 0.3936E 01
FO(4)= 0.4829E-00	RO= 0.3927E 01
FO(5)= 0.4829E-00	RO= 0.3920E 01
FO(6)= 0.4829E-00	RO= 0.3913E 01
FO(7)= 0.4829E-00	RO= 0.3907E 01
FO(8)= 0.4829E-00	RO= 0.3901E 01
FO(9)= 0.4829E-00	RO= 0.3896E 01
FO(10)= 0.4829E-00	RO= 0.3890E 01
FO(11)= 0.4829E-00	RO= 0.3884E 01
FO(12)= 0.4830E-00	RO= 0.3878E 01
FO(13)= 0.4830E-00	RO= 0.3873E 01
FO(14)= 0.4830E-00	RO= 0.3867E 01
FO(15)= 0.4830E-00	RO= 0.3861E 01
FO(16)= 0.4830E-00	RO= 0.3855E 01
FO(17)= 0.4830E-00	RO= 0.3849E 01
FO(18)= 0.4830E-00	RO= 0.3842E 01
FO(19)= 0.4830E-00	RO= 0.3836E 01
FO(20)= 0.4830E-00	RO= 0.3829E 01
FO(21)= 0.4831E-00	RO= 0.3822E 01
FO(22)= 0.4831E-00	RO= 0.3815E 01
FO(23)= 0.4831E-00	RO= 0.3808E 01
FO(24)= 0.4831E-00	RO= 0.3800E 01
FO(25)= 0.4831E-00	RO= 0.3793E 01
FO(26)= 0.4831E-00	RO= 0.3785E 01
FO(27)= 0.4831E-00	RO= 0.3776E 01
FO(28)= 0.4832E-00	RO= 0.3768E 01
FO(29)= 0.4832E-00	RO= 0.3758E 01
FO(30)= 0.4832E-00	RO= 0.3749E 01
FO(31)= 0.4832E-00	RO= 0.3739E 01
FO(32)= 0.4833E-00	RO= 0.3729E 01
FO(33)= 0.4833E-00	RO= 0.3719E 01
FO(34)= 0.4833E-00	RO= 0.3708E 01
FO(35)= 0.4833E-00	RO= 0.3696E 01
FO(36)= 0.4834E-00	RO= 0.3685E 01
FO(37)= 0.4834E-00	RO= 0.3672E 01
FO(38)= 0.4834E-00	RO= 0.3659E 01
FO(39)= 0.4835E-00	RO= 0.3646E 01
FO(40)= 0.4835E-00	RO= 0.3632E 01
FO(41)= 0.4836E-00	RO= 0.3617E 01
FO(42)= 0.4836E-00	RO= 0.3602E 01
FO(43)= 0.4837E-00	RO= 0.3586E 01
FO(44)= 0.4837E-00	RO= 0.3570E 01
FO(45)= 0.4838E-00	RO= 0.3553E 01
FO(46)= 0.4838E-00	RO= 0.3535E 01
FO(47)= 0.4839E-00	RO= 0.3516E 01
FO(48)= 0.4840E-00	RO= 0.3496E 01
FO(49)= 0.4841E-00	RO= 0.3476E 01

OPTIMUM MARS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

FO(50)= 0.4841E-00	RO= 0.3455E 01
FO(51)= 0.4842E-00	RO= 0.3432E 01
FO(52)= 0.4843E-00	RO= 0.3409E 01
FO(53)= 0.4844E-00	RO= 0.3385E 01
FO(54)= 0.4846E-00	RO= 0.3359E 01
FO(55)= 0.4847E-00	RO= 0.3333E 01
FO(56)= 0.4848E-00	RO= 0.3305E 01
FO(57)= 0.4850E-00	RO= 0.3276E 01
FO(58)= 0.4852E-00	RO= 0.3246E 01
FO(59)= 0.4853E-00	RO= 0.3215E 01
FO(60)= 0.4855E-00	RO= 0.3182E 01
FO(61)= 0.4858E-00	RO= 0.3148E 01
FO(62)= 0.4860E-00	RO= 0.3112E 01
FO(63)= 0.4863E-00	RO= 0.3074E 01
FO(64)= 0.4866E-00	RO= 0.3035E 01
FO(65)= 0.4869E-00	RO= 0.2995E 01
FO(66)= 0.4873E-00	RO= 0.2952E 01
FO(67)= 0.4877E-00	RO= 0.2908E 01
FO(68)= 0.4881E-00	RO= 0.2861E 01
FO(69)= 0.4886E-00	RO= 0.2813E 01
FO(70)= 0.4891E-00	RO= 0.2763E 01
FO(71)= 0.4898E-00	RO= 0.2710E 01
FO(72)= 0.4904E-00	RO= 0.2655E 01
FO(73)= 0.4912E-00	RO= 0.2598E 01
FO(74)= 0.4921E-00	RO= 0.2539E 01
FO(75)= 0.4930E-00	RO= 0.2476E 01
FO(76)= 0.4941E-00	RO= 0.2412E 01
FO(77)= 0.4954E-00	RO= 0.2344E 01
FO(78)= 0.4968E-00	RO= 0.2274E 01
FO(79)= 0.4984E-00	RO= 0.2201E 01
FO(80)= 0.5002E 00	RO= 0.2125E 01
FO(81)= 0.5023E 00	RO= 0.2046E 01
FO(82)= 0.5047E 00	RO= 0.1964E 01
FO(83)= 0.5075E 00	RO= 0.1879E 01
FO(84)= 0.5108E 00	RO= 0.1791E 01
FO(85)= 0.5146E 00	RO= 0.1700E 01
FO(86)= 0.5191E 00	RO= 0.1605E 01
FO(87)= 0.5244E 00	RO= 0.1508E 01
FO(88)= 0.5307E 00	RO= 0.1407E 01
FO(89)= 0.5384E 00	RO= 0.1304E 01
FO(90)= 0.5477E 00	RO= 0.1197E 01

Mars A-Trajectory

OPTIMUM MARS A-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

CORRECTION RADII -- INNER AND OUTER ERRORS

	R	FIR	VR	H
2	0.1100E 01	0.1540E 01	0.2305E 01	0.2536E 01
3	0.1166E 01	0.1261E 01	0.2283E 01	0.2547E 01
4	0.1235E 01	0.1136E 01	0.2262E 01	0.2552E 01
5	0.1309E 01	0.1042E 01	0.2242E 01	0.2557E 01
6	0.1386E 01	0.9649E 00	0.2222E 01	0.2561E 01
7	0.1471E 01	0.8980E 00	0.2204E 01	0.2565E 01
8	0.1559E 01	0.8388E 00	0.2186E 01	0.2569E 01
9	0.1652E 01	0.7856E 00	0.2170E 01	0.2573E 01
10	0.1751E 01	0.7373E 00	0.2154E 01	0.2576E 01
11	0.1855E 01	0.6929E 00	0.2139E 01	0.2580E 01
12	0.1966E 01	0.6520E 00	0.2125E 01	0.2584E 01
13	0.2084E 01	0.6141E 00	0.2111E 01	0.2588E 01
14	0.2208E 01	0.5788E 00	0.2098E 01	0.2593E 01
15	0.2340E 01	0.5459E 00	0.2086E 01	0.2597E 01
16	0.2480E 01	0.5151E 00	0.2074E 01	0.2602E 01
17	0.2629E 01	0.4863E-00	0.2063E 01	0.2606E 01
18	0.2786E 01	0.4592E-00	0.2053E 01	0.2611E 01
19	0.2952E 01	0.4337E-00	0.2043E 01	0.2617E 01
20	0.3129E 01	0.4097E-00	0.2034E 01	0.2622E 01
21	0.3316E 01	0.3871E-00	0.2025E 01	0.2628E 01
22	0.3514E 01	0.3658E-00	0.2016E 01	0.2634E 01
23	0.3725E 01	0.3457E-00	0.2008E 01	0.2640E 01
24	0.3947E 01	0.3267E-00	0.2001E 01	0.2647E 01
25	0.4183E 01	0.3088E-00	0.1994E 01	0.2654E 01
26	0.4433E 01	0.2919E-00	0.1987E 01	0.2661E 01
27	0.4699E 01	0.2759E-00	0.1981E 01	0.2669E 01
28	0.4979E 01	0.2608E-00	0.1974E 01	0.2677E 01
29	0.5277E 01	0.2465E-00	0.1969E 01	0.2686E 01
30	0.5593E 01	0.2330E-00	0.1963E 01	0.2695E 01
31	0.5927E 01	0.2202E-00	0.1958E 01	0.2704E 01
32	0.6282E 01	0.2081E-00	0.1953E 01	0.2715E 01
33	0.6657E 01	0.1967E-00	0.1949E 01	0.2725E 01
34	0.7055E 01	0.1858E-00	0.1944E 01	0.2737E 01
35	0.7477E 01	0.1756E-00	0.1940E 01	0.2749E 01
36	0.7924E 01	0.1660E-00	0.1936E 01	0.2761E 01
37	0.8398E 01	0.1568E-00	0.1933E 01	0.2775E 01
38	0.8900E 01	0.1482E-00	0.1929E 01	0.2789E 01
39	0.9433E 01	0.1400E-00	0.1926E 01	0.2804E 01
40	0.9997E 01	0.1323E-00	0.1923E 01	0.2820E 01
41	0.1059E 02	0.1249E-00	0.1920E 01	0.2837E 01
42	0.1123E 02	0.1180E-00	0.1917E 01	0.2855E 01
43	0.1190E 02	0.1115E-00	0.1914E 01	0.2874E 01
44	0.1261E 02	0.1053E-00	0.1912E 01	0.2894E 01
45	0.1336E 02	0.9948E-01	0.1910E 01	0.2915E 01
46	0.1416E 02	0.9396E-01	0.1907E 01	0.2938E 01
47	0.1501E 02	0.8874E-01	0.1905E 01	0.2962E 01
48	0.1591E 02	0.8381E-01	0.1903E 01	0.2987E 01
49	0.1686E 02	0.7915E-01	0.1901E 01	0.3014E 01

OPTIMUM MARS A-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

	R	FIR	VR	H
50	0.1787E 02	0.7474E-01	0.1900E 01	0.3042E 01
51	0.1894E 02	0.7058E-01	0.1898E 01	0.3072E 01
52	0.2007E 02	0.6665E-01	0.1896E 01	0.3104E 01
53	0.2127E 02	0.6293E-01	0.1895E 01	0.3138E 01
54	0.2254E 02	0.5942E-01	0.1894E 01	0.3174E 01
55	0.2389E 02	0.5610E-01	0.1892E 01	0.3211E 01
56	0.2532E 02	0.5297E-01	0.1891E 01	0.3252E 01
57	0.2683E 02	0.5001E-01	0.1890E 01	0.3294E 01
58	0.2844E 02	0.4721E-01	0.1889E 01	0.3339E 01
59	0.3014E 02	0.4457E-01	0.1888E 01	0.3387E 01
60	0.3194E 02	0.4208E-01	0.1887E 01	0.3437E 01
61	0.3385E 02	0.3972E-01	0.1886E 01	0.3491E 01
62	0.3587E 02	0.3750E-01	0.1885E 01	0.3548E 01
63	0.3802E 02	0.3540E-01	0.1884E 01	0.3608E 01
64	0.4029E 02	0.3341E-01	0.1883E 01	0.3672E 01
65	0.4270E 02	0.3154E-01	0.1882E 01	0.3739E 01
66	0.4525E 02	0.2977E-01	0.1882E 01	0.3811E 01
67	0.4796E 02	0.2810E-01	0.1881E 01	0.3887E 01
68	0.5083E 02	0.2652E-01	0.1880E 01	0.3968E 01
69	0.5387E 02	0.2503E-01	0.1880E 01	0.4053E 01
70	0.5709E 02	0.2363E-01	0.1879E 01	0.4143E 01
71	0.6050E 02	0.2230E-01	0.1879E 01	0.4239E 01
72	0.6412E 02	0.2105E-01	0.1878E 01	0.4340E 01
73	0.6795E 02	0.1987E-01	0.1878E 01	0.4448E 01
74	0.7202E 02	0.1875E-01	0.1877E 01	0.4562E 01
75	0.7632E 02	0.1770E-01	0.1877E 01	0.4683E 01
76	0.8089E 02	0.1670E-01	0.1877E 01	0.4811E 01
77	0.8572E 02	0.1576E-01	0.1876E 01	0.4946E 01
78	0.9085E 02	0.1487E-01	0.1876E 01	0.5090E 01
79	0.9628E 02	0.1404E-01	0.1876E 01	0.5243E 01
80	0.1020E 03	0.1325E-01	0.1875E 01	0.5404E 01
81	0.1081E 03	0.1250E-01	0.1875E 01	0.5575E 01
82	0.1146E 03	0.1180E-01	0.1875E 01	0.5757E 01
83	0.1215E 03	0.1113E-01	0.1874E 01	0.5949E 01
84	0.1287E 03	0.1051E-01	0.1874E 01	0.6153E 01
85	0.1364E 03	0.9916E-02	0.1874E 01	0.6368E 01
86	0.1446E 03	0.9357E-02	0.1874E 01	0.6597E 01
87	0.1532E 03	0.8830E-02	0.1873E 01	0.6840E 01
88	0.1624E 03	0.8333E-02	0.1873E 01	0.7097E 01
89	0.1721E 03	0.7864E-02	0.1873E 01	0.7369E 01
90	0.1824E 03	0.7421E-02	0.1873E 01	0.7658E 01
91	0.1933E 03	0.7002E-02	0.1873E 01	0.7964E 01
92	0.2048E 03	0.6608E-02	0.1873E 01	0.8288E 01
93	0.2171E 03	0.6236E-02	0.1872E 01	0.8631E 01
94	0.2301E 03	0.5884E-02	0.1872E 01	0.8995E 01
95	0.2438E 03	0.5553E-02	0.1872E 01	0.9381E 01
96	0.2584E 03	0.5240E-02	0.1872E 01	0.9790E 01
97	0.2739E 03	0.4944E-02	0.1872E 01	0.1022E 02
98	0.2902E 03	0.4666E-02	0.1872E 01	0.1068E 02
99	0.3076E 03	0.4403E-02	0.1872E 01	0.1117E 02
100	0.3260E 03	0.4154E-02	0.1872E 01	0.1169E 02

OPTIMUM MARS A-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

POSSIBLE ORBITAL IMPULSES (DV/VCS)-- OUTER ERRORS

FO(2)= 0.1352E 01	RO= 0.1100E 01
FO(3)= 0.1352E 01	RO= 0.1106E 01
FO(4)= 0.1353E 01	RO= 0.1108E 01
FO(5)= 0.1353E 01	RO= 0.1111E 01
FO(6)= 0.1353E 01	RO= 0.1113E 01
FO(7)= 0.1353E 01	RO= 0.1115E 01
FO(8)= 0.1353E 01	RO= 0.1117E 01
FO(9)= 0.1353E 01	RO= 0.1119E 01
FO(10)= 0.1354E 01	RO= 0.1121E 01
FO(11)= 0.1354E 01	RO= 0.1123E 01
FO(12)= 0.1354E 01	RO= 0.1125E 01
FO(13)= 0.1354E 01	RO= 0.1127E 01
FO(14)= 0.1354E 01	RO= 0.1130E 01
FO(15)= 0.1354E 01	RO= 0.1132E 01
FO(16)= 0.1355E 01	RO= 0.1134E 01
FO(17)= 0.1355E 01	RO= 0.1137E 01
FO(18)= 0.1355E 01	RO= 0.1139E 01
FO(19)= 0.1355E 01	RO= 0.1142E 01
FO(20)= 0.1355E 01	RO= 0.1145E 01
FO(21)= 0.1356E 01	RO= 0.1148E 01
FO(22)= 0.1356E 01	RO= 0.1151E 01
FO(23)= 0.1356E 01	RO= 0.1155E 01
FO(24)= 0.1356E 01	RO= 0.1158E 01
FO(25)= 0.1357E 01	RO= 0.1162E 01
FO(26)= 0.1357E 01	RO= 0.1165E 01
FO(27)= 0.1357E 01	RO= 0.1170E 01
FO(28)= 0.1358E 01	RO= 0.1174E 01
FO(29)= 0.1358E 01	RO= 0.1178E 01
FO(30)= 0.1358E 01	RO= 0.1183E 01
FO(31)= 0.1359E 01	RO= 0.1188E 01
FO(32)= 0.1359E 01	RO= 0.1194E 01
FO(33)= 0.1359E 01	RO= 0.1199E 01
FO(34)= 0.1360E 01	RO= 0.1205E 01
FO(35)= 0.1360E 01	RO= 0.1212E 01
FO(36)= 0.1361E 01	RO= 0.1218E 01
FO(37)= 0.1361E 01	RO= 0.1225E 01
FO(38)= 0.1362E 01	RO= 0.1233E 01
FO(39)= 0.1363E 01	RO= 0.1241E 01
FO(40)= 0.1363E 01	RO= 0.1249E 01
FO(41)= 0.1364E 01	RO= 0.1258E 01
FO(42)= 0.1364E 01	RO= 0.1267E 01
FO(43)= 0.1365E 01	RO= 0.1277E 01
FO(44)= 0.1366E 01	RO= 0.1288E 01
FO(45)= 0.1367E 01	RO= 0.1299E 01
FO(46)= 0.1368E 01	RO= 0.1311E 01
FO(47)= 0.1369E 01	RO= 0.1323E 01
FO(48)= 0.1370E 01	RO= 0.1337E 01
FO(49)= 0.1371E 01	RO= 0.1351E 01

OPTIMUM MARS A-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

FO(50)=	0.1372E 01	RO=	0.1366E 01
FO(51)=	0.1373E 01	RO=	0.1382E 01
FO(52)=	0.1374E 01	RO=	0.1398E 01
FO(53)=	0.1375E 01	RO=	0.1416E 01
FO(54)=	0.1377E 01	RO=	0.1435E 01
FO(55)=	0.1378E 01	RO=	0.1455E 01
FO(56)=	0.1380E 01	RO=	0.1476E 01
FO(57)=	0.1381E 01	RO=	0.1499E 01
FO(58)=	0.1383E 01	RO=	0.1522E 01
FO(59)=	0.1385E 01	RO=	0.1548E 01
FO(60)=	0.1386E 01	RO=	0.1574E 01
FO(61)=	0.1388E 01	RO=	0.1603E 01
FO(62)=	0.1390E 01	RO=	0.1633E 01
FO(63)=	0.1392E 01	RO=	0.1665E 01
FO(64)=	0.1395E 01	RO=	0.1698E 01
FO(65)=	0.1397E 01	RO=	0.1734E 01
FO(66)=	0.1399E 01	RO=	0.1772E 01
FO(67)=	0.1402E 01	RO=	0.1812E 01
FO(68)=	0.1405E 01	RO=	0.1855E 01
FO(69)=	0.1407E 01	RO=	0.1900E 01
FO(70)=	0.1410E 01	RO=	0.1948E 01
FO(71)=	0.1413E 01	RO=	0.1999E 01
FO(72)=	0.1417E 01	RO=	0.2053E 01
FO(73)=	0.1420E 01	RO=	0.2110E 01
FO(74)=	0.1423E 01	RO=	0.2170E 01
FO(75)=	0.1427E 01	RO=	0.2234E 01
FO(76)=	0.1430E 01	RO=	0.2302E 01
FO(77)=	0.1434E 01	RO=	0.2375E 01
FO(78)=	0.1438E 01	RO=	0.2451E 01
FO(79)=	0.1442E 01	RO=	0.2532E 01
FO(80)=	0.1446E 01	RO=	0.2618E 01
FO(81)=	0.1450E 01	RO=	0.2709E 01
FO(82)=	0.1455E 01	RO=	0.2806E 01
FO(83)=	0.1459E 01	RO=	0.2908E 01
FO(84)=	0.1464E 01	RO=	0.3017E 01
FO(85)=	0.1469E 01	RO=	0.3132E 01
FO(86)=	0.1473E 01	RO=	0.3254E 01
FO(87)=	0.1478E 01	RO=	0.3383E 01
FO(88)=	0.1483E 01	RO=	0.3520E 01
FO(89)=	0.1488E 01	RO=	0.3665E 01
FO(90)=	0.1493E 01	RO=	0.3819E 01
FO(91)=	0.1499E 01	RO=	0.3982E 01
FO(92)=	0.1504E 01	RO=	0.4155E 01
FO(93)=	0.1509E 01	RO=	0.4339E 01
FO(94)=	0.1515E 01	RO=	0.4533E 01
FO(95)=	0.1520E 01	RO=	0.4739E 01
FO(96)=	0.1526E 01	RO=	0.4957E 01
FO(97)=	0.1531E 01	RO=	0.5189E 01
FO(98)=	0.1537E 01	RO=	0.5434E 01
FO(99)=	0.1543E 01	RO=	0.5694E 01
FO(100)=	0.1548E 01	RO=	0.5970E 01

OPTIMUM MARS A-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

POSSIBLE ORBITAL IMPULSES (DV/VCS)-- INNER ERRORS

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FO(  2)= 0.1352E 01      RO= 0.1099E 01
FO(  3)= 0.1351E 01      RO= 0.1093E 01
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Venus H-Trajectory

Orbital Range

1.1 to 6.1

OPTIMUM VENUS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

CORRECTION RADII -- INNER AND OUTER ERRORS

	R	FIR	VR	H
2	0.6100E 01	0.1571E 01	0.6659E 00	0.4062E 01
3	0.6314E 01	0.1364E 01	0.6575E 00	0.4071E 01
4	0.6535E 01	0.1278E 01	0.6493E 00	0.4074E 01
5	0.6764E 01	0.1213E 01	0.6412E 00	0.4077E 01
6	0.7001E 01	0.1158E 01	0.6334E 00	0.4080E 01
7	0.7246E 01	0.1111E 01	0.6257E 00	0.4082E 01
8	0.7499E 01	0.1068E 01	0.6182E 00	0.4085E 01
9	0.7762E 01	0.1029E 01	0.6109E 00	0.4087E 01
10	0.8034E 01	0.9929E 00	0.6037E 00	0.4089E 01
11	0.8315E 01	0.9593E 00	0.5967E 00	0.4091E 01
12	0.8607E 01	0.9278E 00	0.5898E 00	0.4093E 01
13	0.8908E 01	0.8980E 00	0.5831E 00	0.4095E 01
14	0.9220E 01	0.8698E 00	0.5766E 00	0.4097E 01
15	0.9543E 01	0.8430E 00	0.5702E 00	0.4098E 01
16	0.9877E 01	0.8174E 00	0.5639E 00	0.4100E 01
17	0.1022E 02	0.7929E 00	0.5578E 00	0.4102E 01
18	0.1058E 02	0.7695E 00	0.5518E 00	0.4104E 01
19	0.1095E 02	0.7469E 00	0.5460E 00	0.4106E 01
20	0.1134E 02	0.7252E 00	0.5403E 00	0.4108E 01
21	0.1173E 02	0.7043E 00	0.5348E 00	0.4110E 01
22	0.1214E 02	0.6841E 00	0.5293E 00	0.4112E 01
23	0.1257E 02	0.6647E 00	0.5241E 00	0.4114E 01
24	0.1301E 02	0.6458E 00	0.5189E 00	0.4116E 01
25	0.1346E 02	0.6276E 00	0.5139E 00	0.4118E 01
26	0.1394E 02	0.6099E 00	0.5089E 00	0.4120E 01
27	0.1442E 02	0.5928E 00	0.5041E 00	0.4123E 01
28	0.1493E 02	0.5762E 00	0.4995E-00	0.4125E 01
29	0.1545E 02	0.5601E 00	0.4949E-00	0.4127E 01
30	0.1599E 02	0.5444E 00	0.4905E-00	0.4129E 01
31	0.1655E 02	0.5292E 00	0.4861E-00	0.4132E 01
32	0.1713E 02	0.5144E 00	0.4819E-00	0.4134E 01
33	0.1773E 02	0.5001E 00	0.4778E-00	0.4137E 01
34	0.1835E 02	0.4861E-00	0.4738E-00	0.4139E 01
35	0.1900E 02	0.4725E-00	0.4699E-00	0.4142E 01
36	0.1966E 02	0.4593E-00	0.4661E-00	0.4144E 01
37	0.2035E 02	0.4464E-00	0.4624E-00	0.4147E 01
38	0.2106E 02	0.4339E-00	0.4588E-00	0.4150E 01
39	0.2180E 02	0.4217E-00	0.4552E-00	0.4153E 01
40	0.2256E 02	0.4099E-00	0.4518E-00	0.4156E 01
41	0.2335E 02	0.3983E-00	0.4485E-00	0.4159E 01
42	0.2417E 02	0.3870E-00	0.4452E-00	0.4162E 01
43	0.2502E 02	0.3761E-00	0.4421E-00	0.4165E 01
44	0.2590E 02	0.3654E-00	0.4390E-00	0.4168E 01
45	0.2680E 02	0.3550E-00	0.4360E-00	0.4172E 01
46	0.2774E 02	0.3449E-00	0.4331E-00	0.4175E 01
47	0.2871E 02	0.3350E-00	0.4303E-00	0.4179E 01
48	0.2972E 02	0.3254E-00	0.4276E-00	0.4183E 01
49	0.3076E 02	0.3161E-00	0.4249E-00	0.4186E 01

OPTIMUM VENUS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

	R	FIR	VR	H
50	0.3184E 02	0.3070E-00	0.4223E-00	0.4190E 01
51	0.3295E 02	0.2981E-00	0.4198E-00	0.4194E 01
52	0.3411E 02	0.2895E-00	0.4173E-00	0.4199E 01
53	0.3530E 02	0.2810E-00	0.4149E-00	0.4203E 01
54	0.3654E 02	0.2729E-00	0.4126E-00	0.4207E 01
55	0.3782E 02	0.2649E-00	0.4104E-00	0.4212E 01
56	0.3914E 02	0.2571E-00	0.4082E-00	0.4217E 01
57	0.4051E 02	0.2495E-00	0.4060E-00	0.4222E 01
58	0.4193E 02	0.2422E-00	0.4040E-00	0.4227E 01
59	0.4340E 02	0.2350E-00	0.4020E-00	0.4232E 01
60	0.4492E 02	0.2281E-00	0.4000E-00	0.4237E 01
61	0.4649E 02	0.2213E-00	0.3981E-00	0.4243E 01
62	0.4812E 02	0.2147E-00	0.3963E-00	0.4249E 01
63	0.4981E 02	0.2082E-00	0.3945E-00	0.4254E 01
64	0.5155E 02	0.2020E-00	0.3928E-00	0.4261E 01
65	0.5335E 02	0.1959E-00	0.3911E-00	0.4267E 01
66	0.5522E 02	0.1900E-00	0.3895E-00	0.4273E 01
67	0.5716E 02	0.1843E-00	0.3879E-00	0.4280E 01
68	0.5916E 02	0.1787E-00	0.3864E-00	0.4287E 01
69	0.6123E 02	0.1732E-00	0.3849E-00	0.4294E 01
70	0.6338E 02	0.1679E-00	0.3835E-00	0.4302E 01
71	0.6560E 02	0.1628E-00	0.3821E-00	0.4310E 01
72	0.6789E 02	0.1578E-00	0.3807E-00	0.4318E 01
73	0.7027E 02	0.1530E-00	0.3794E-00	0.4326E 01
74	0.7273E 02	0.1482E-00	0.3782E-00	0.4334E 01
75	0.7528E 02	0.1437E-00	0.3769E-00	0.4343E 01
76	0.7792E 02	0.1392E-00	0.3757E-00	0.4352E 01
77	0.8064E 02	0.1349E-00	0.3746E-00	0.4362E 01
78	0.8347E 02	0.1307E-00	0.3734E-00	0.4371E 01
79	0.8639E 02	0.1266E-00	0.3724E-00	0.4381E 01
80	0.8942E 02	0.1227E-00	0.3713E-00	0.4392E 01
81	0.9255E 02	0.1188E-00	0.3703E-00	0.4402E 01
82	0.9579E 02	0.1151E-00	0.3693E-00	0.4414E 01
83	0.9915E 02	0.1115E-00	0.3683E-00	0.4425E 01
84	0.1026E 03	0.1080E-00	0.3674E-00	0.4437E 01
85	0.1062E 03	0.1045E-00	0.3665E-00	0.4449E 01
86	0.1099E 03	0.1012E-00	0.3656E-00	0.4462E 01
87	0.1138E 03	0.9803E-01	0.3648E-00	0.4475E 01
88	0.1178E 03	0.9492E-01	0.3640E-00	0.4489E 01
89	0.1219E 03	0.9189E-01	0.3632E-00	0.4503E 01
90	0.1262E 03	0.8896E-01	0.3624E-00	0.4518E 01
91	0.1306E 03	0.8612E-01	0.3617E-00	0.4533E 01
92	0.1352E 03	0.8337E-01	0.3610E-00	0.4548E 01
93	0.1399E 03	0.8070E-01	0.3603E-00	0.4565E 01
94	0.1448E 03	0.7811E-01	0.3596E-00	0.4581E 01
95	0.1499E 03	0.7559E-01	0.3590E-00	0.4599E 01
96	0.1551E 03	0.7316E-01	0.3583E-00	0.4616E 01
97	0.1605E 03	0.7080E-01	0.3577E-00	0.4635E 01
98	0.1662E 03	0.6851E-01	0.3571E-00	0.4654E 01
99	0.1720E 03	0.6630E-01	0.3566E-00	0.4674E 01
100	0.1780E 03	0.6415E-01	0.3560E-00	0.4695E 01

OPTIMUM VENUS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

POSSIBLE ORBITAL IMPULSES (DV/VCS)-- OUTER ERRORS

FO(2)= 0.2610E-00	RO= 0.6101E 01
FO(3)= 0.2608E-00	RO= 0.6121E 01
FO(4)= 0.2608E-00	RO= 0.6130E 01
FO(5)= 0.2607E-00	RO= 0.6137E 01
FO(6)= 0.2607E-00	RO= 0.6144E 01
FO(7)= 0.2606E-00	RO= 0.6149E 01
FO(8)= 0.2606E-00	RO= 0.6154E 01
FO(9)= 0.2606E-00	RO= 0.6159E 01
FO(10)= 0.2605E-00	RO= 0.6164E 01
FO(11)= 0.2605E-00	RO= 0.6169E 01
FO(12)= 0.2605E-00	RO= 0.6174E 01
FO(13)= 0.2604E-00	RO= 0.6178E 01
FO(14)= 0.2604E-00	RO= 0.6183E 01
FO(15)= 0.2604E-00	RO= 0.6188E 01
FO(16)= 0.2603E-00	RO= 0.6192E 01
FO(17)= 0.2603E-00	RO= 0.6197E 01
FO(18)= 0.2603E-00	RO= 0.6201E 01
FO(19)= 0.2602E-00	RO= 0.6206E 01
FO(20)= 0.2602E-00	RO= 0.6211E 01
FO(21)= 0.2602E-00	RO= 0.6215E 01
FO(22)= 0.2601E-00	RO= 0.6220E 01
FO(23)= 0.2601E-00	RO= 0.6225E 01
FO(24)= 0.2601E-00	RO= 0.6230E 01
FO(25)= 0.2600E-00	RO= 0.6235E 01
FO(26)= 0.2600E-00	RO= 0.6240E 01
FO(27)= 0.2600E-00	RO= 0.6245E 01
FO(28)= 0.2599E-00	RO= 0.6251E 01
FO(29)= 0.2599E-00	RO= 0.6256E 01
FO(30)= 0.2598E-00	RO= 0.6261E 01
FO(31)= 0.2598E-00	RO= 0.6267E 01
FO(32)= 0.2598E-00	RO= 0.6273E 01
FO(33)= 0.2597E-00	RO= 0.6279E 01
FO(34)= 0.2597E-00	RO= 0.6285E 01
FO(35)= 0.2596E-00	RO= 0.6291E 01
FO(36)= 0.2596E-00	RO= 0.6298E 01
FO(37)= 0.2596E-00	RO= 0.6304E 01
FO(38)= 0.2595E-00	RO= 0.6311E 01
FO(39)= 0.2595E-00	RO= 0.6318E 01
FO(40)= 0.2594E-00	RO= 0.6325E 01
FO(41)= 0.2594E-00	RO= 0.6332E 01
FO(42)= 0.2593E-00	RO= 0.6340E 01
FO(43)= 0.2593E-00	RO= 0.6347E 01
FO(44)= 0.2592E-00	RO= 0.6355E 01
FO(45)= 0.2592E-00	RO= 0.6363E 01
FO(46)= 0.2591E-00	RO= 0.6372E 01
FO(47)= 0.2591E-00	RO= 0.6381E 01
FO(48)= 0.2590E-00	RO= 0.6389E 01
FO(49)= 0.2589E-00	RO= 0.6399E 01

OPTIMUM VENUS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

```
FO( 50)= 0.2589E-00      RO= 0.6408E 01
FO( 51)= 0.2588E-00      RO= 0.6418E 01
FO( 52)= 0.2588E-00      RO= 0.6428E 01
FO( 53)= 0.2587E-00      RO= 0.6438E 01
FO( 54)= 0.2586E-00      RO= 0.6449E 01
FO( 55)= 0.2586E-00      RO= 0.6460E 01
FO( 56)= 0.2585E-00      RO= 0.6472E 01
FO( 57)= 0.2584E-00      RO= 0.6483E 01
FO( 58)= 0.2583E-00      RO= 0.6496E 01
FO( 59)= 0.2583E-00      RO= 0.6508E 01
FO( 60)= 0.2582E-00      RO= 0.6521E 01
FO( 61)= 0.2581E-00      RO= 0.6535E 01
FO( 62)= 0.2580E-00      RO= 0.6549E 01
FO( 63)= 0.2579E-00      RO= 0.6563E 01
FO( 64)= 0.2578E-00      RO= 0.6578E 01
FO( 65)= 0.2577E-00      RO= 0.6593E 01
FO( 66)= 0.2576E-00      RO= 0.6609E 01
```

OPTIMUM VENUS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

POSSIBLE ORBITAL IMPULSES (DV/VCS)-- INNER ERRORS

FO(2)=	0.2627E-00	RO=	0.6101E 01
FO(3)=	0.2628E-00	RO=	0.6081E 01
FO(4)=	0.2629E-00	RO=	0.6072E 01
FO(5)=	0.2629E-00	RO=	0.6065E 01
FO(6)=	0.2630E-00	RO=	0.6059E 01
FO(7)=	0.2630E-00	RO=	0.6053E 01
FO(8)=	0.2630E-00	RO=	0.6048E 01
FO(9)=	0.2631E-00	RO=	0.6043E 01
FO(10)=	0.2631E-00	RO=	0.6038E 01
FO(11)=	0.2631E-00	RO=	0.6033E 01
FO(12)=	0.2632E-00	RO=	0.6029E 01
FO(13)=	0.2632E-00	RO=	0.6024E 01
FO(14)=	0.2632E-00	RO=	0.6020E 01
FO(15)=	0.2633E-00	RO=	0.6015E 01
FO(16)=	0.2633E-00	RO=	0.6011E 01
FO(17)=	0.2633E-00	RO=	0.6006E 01
FO(18)=	0.2634E-00	RO=	0.6001E 01
FO(19)=	0.2634E-00	RO=	0.5997E 01
FO(20)=	0.2634E-00	RO=	0.5992E 01
FO(21)=	0.2635E-00	RO=	0.5988E 01
FO(22)=	0.2635E-00	RO=	0.5983E 01
FO(23)=	0.2635E-00	RO=	0.5978E 01
FO(24)=	0.2636E-00	RO=	0.5973E 01
FO(25)=	0.2636E-00	RO=	0.5968E 01
FO(26)=	0.2637E-00	RO=	0.5963E 01
FO(27)=	0.2637E-00	RO=	0.5958E 01
FO(28)=	0.2637E-00	RO=	0.5953E 01
FO(29)=	0.2638E-00	RO=	0.5947E 01
FO(30)=	0.2638E-00	RO=	0.5942E 01
FO(31)=	0.2639E-00	RO=	0.5936E 01
FO(32)=	0.2639E-00	RO=	0.5930E 01
FO(33)=	0.2639E-00	RO=	0.5925E 01
FO(34)=	0.2640E-00	RO=	0.5918E 01
FO(35)=	0.2640E-00	RO=	0.5912E 01
FO(36)=	0.2641E-00	RO=	0.5906E 01
FO(37)=	0.2641E-00	RO=	0.5900E 01
FO(38)=	0.2642E-00	RO=	0.5893E 01
FO(39)=	0.2642E-00	RO=	0.5886E 01
FO(40)=	0.2643E-00	RO=	0.5879E 01
FO(41)=	0.2643E-00	RO=	0.5872E 01
FO(42)=	0.2644E-00	RO=	0.5864E 01
FO(43)=	0.2645E-00	RO=	0.5857E 01
FO(44)=	0.2645E-00	RO=	0.5849E 01
FO(45)=	0.2646E-00	RO=	0.5841E 01
FO(46)=	0.2646E-00	RO=	0.5833E 01
FO(47)=	0.2647E-00	RO=	0.5824E 01
FO(48)=	0.2648E-00	RO=	0.5815E 01
FO(49)=	0.2649E-00	RO=	0.5806E 01

OPTIMUM VENUS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 6.1

```
FO( 50)= 0.2649E-00      RO= 0.5797E 01
FO( 51)= 0.2650E-00      RO= 0.5787E 01
FO( 52)= 0.2651E-00      RO= 0.5778E 01
FO( 53)= 0.2652E-00      RO= 0.5767E 01
FO( 54)= 0.2652E-00      RO= 0.5757E 01
FO( 55)= 0.2653E-00      RO= 0.5746E 01
FO( 56)= 0.2654E-00      RO= 0.5735E 01
FO( 57)= 0.2655E-00      RO= 0.5723E 01
FO( 58)= 0.2656E-00      RO= 0.5711E 01
FO( 59)= 0.2657E-00      RO= 0.5699E 01
FO( 60)= 0.2658E-00      RO= 0.5686E 01
FO( 61)= 0.2659E-00      RO= 0.5673E 01
FO( 62)= 0.2660E-00      RO= 0.5660E 01
FO( 63)= 0.2662E-00      RO= 0.5646E 01
FO( 64)= 0.2663E-00      RO= 0.5632E 01
FO( 65)= 0.2664E-00      RO= 0.5617E 01
FO( 66)= 0.2665E-00      RO= 0.5601E 01
FO( 67)= 0.2667E-00      RO= 0.5586E 01
FO( 68)= 0.2668E-00      RO= 0.5569E 01
FO( 69)= 0.2670E-00      RO= 0.5552E 01
FO( 70)= 0.2671E-00      RO= 0.5535E 01
FO( 71)= 0.2673E-00      RO= 0.5517E 01
FO( 72)= 0.2674E-00      RO= 0.5498E 01
FO( 73)= 0.2676E-00      RO= 0.5479E 01
FO( 74)= 0.2678E-00      RO= 0.5459E 01
FO( 75)= 0.2680E-00      RO= 0.5439E 01
FO( 76)= 0.2682E-00      RO= 0.5417E 01
FO( 77)= 0.2684E-00      RO= 0.5395E 01
FO( 78)= 0.2686E-00      RO= 0.5373E 01
FO( 79)= 0.2688E-00      RO= 0.5349E 01
FO( 80)= 0.2690E-00      RO= 0.5325E 01
FO( 81)= 0.2693E-00      RO= 0.5300E 01
FO( 82)= 0.2695E-00      RO= 0.5275E 01
FO( 83)= 0.2698E-00      RO= 0.5248E 01
FO( 84)= 0.2700E-00      RO= 0.5220E 01
FO( 85)= 0.2703E-00      RO= 0.5192E 01
FO( 86)= 0.2706E-00      RO= 0.5163E 01
FO( 87)= 0.2709E-00      RO= 0.5132E 01
FO( 88)= 0.2713E-00      RO= 0.5101E 01
FO( 89)= 0.2716E-00      RO= 0.5068E 01
FO( 90)= 0.2720E-00      RO= 0.5035E 01
FO( 91)= 0.2723E-00      RO= 0.5000E 01
FO( 92)= 0.2727E-00      RO= 0.4965E 01
FO( 93)= 0.2731E-00      RO= 0.4928E 01
FO( 94)= 0.2736E-00      RO= 0.4890E 01
FO( 95)= 0.2740E-00      RO= 0.4851E 01
FO( 96)= 0.2745E-00      RO= 0.4810E 01
FO( 97)= 0.2750E-00      RO= 0.4768E 01
FO( 98)= 0.2755E-00      RO= 0.4725E 01
FO( 99)= 0.2761E-00      RO= 0.4680E 01
FO(100)= 0.2766E-00      RO= 0.4634E 01
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Venus H-Trajectory

Orbital Range

1.1 to 16.1

OPTIMUM VENUS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 16.1

CORRECTION RADII -- OUTER ERRORS

	R	FIR	VR	H
2	0.1610E 02	0.1571E 01	0.5063E 00	0.8151E 01
3	0.1650E 02	0.1379E 01	0.5033E 00	0.8175E 01
4	0.1691E 02	0.1300E 01	0.5004E 00	0.8185E 01
5	0.1733E 02	0.1239E 01	0.4975E-00	0.8193E 01
6	0.1776E 02	0.1189E 01	0.4947E-00	0.8200E 01
7	0.1820E 02	0.1145E 01	0.4919E-00	0.8206E 01
8	0.1865E 02	0.1105E 01	0.4892E-00	0.8212E 01
9	0.1911E 02	0.1069E 01	0.4865E-00	0.8218E 01
10	0.1959E 02	0.1035E 01	0.4839E-00	0.8223E 01
11	0.2008E 02	0.1004E 01	0.4814E-00	0.8229E 01
12	0.2057E 02	0.9746E 00	0.4788E-00	0.8234E 01
13	0.2108E 02	0.9469E 00	0.4764E-00	0.8239E 01
14	0.2161E 02	0.9206E 00	0.4740E-00	0.8244E 01
15	0.2214E 02	0.8956E 00	0.4716E-00	0.8249E 01
16	0.2269E 02	0.8718E 00	0.4693E-00	0.8254E 01
17	0.2326E 02	0.8489E 00	0.4670E-00	0.8259E 01
18	0.2383E 02	0.8270E 00	0.4647E-00	0.8263E 01
19	0.2443E 02	0.8060E 00	0.4626E-00	0.8268E 01
20	0.2503E 02	0.7857E 00	0.4604E-00	0.8273E 01
21	0.2565E 02	0.7661E 00	0.4583E-00	0.8278E 01
22	0.2629E 02	0.7472E 00	0.4562E-00	0.8283E 01
23	0.2694E 02	0.7290E 00	0.4542E-00	0.8288E 01
24	0.2761E 02	0.7113E 00	0.4522E-00	0.8293E 01
25	0.2830E 02	0.6942E 00	0.4503E-00	0.8298E 01
26	0.2900E 02	0.6776E 00	0.4484E-00	0.8303E 01
27	0.2972E 02	0.6615E 00	0.4465E-00	0.8308E 01
28	0.3046E 02	0.6459E 00	0.4447E-00	0.8313E 01
29	0.3121E 02	0.6307E 00	0.4429E-00	0.8318E 01
30	0.3199E 02	0.6159E 00	0.4411E-00	0.8324E 01
31	0.3278E 02	0.6015E 00	0.4394E-00	0.8329E 01
32	0.3360E 02	0.5875E 00	0.4377E-00	0.8334E 01
33	0.3443E 02	0.5739E 00	0.4361E-00	0.8340E 01
34	0.3529E 02	0.5607E 00	0.4345E-00	0.8346E 01
35	0.3616E 02	0.5478E 00	0.4329E-00	0.8351E 01
36	0.3706E 02	0.5352E 00	0.4313E-00	0.8357E 01
37	0.3798E 02	0.5229E 00	0.4298E-00	0.8363E 01
38	0.3892E 02	0.5109E 00	0.4283E-00	0.8369E 01
39	0.3989E 02	0.4992E-00	0.4269E-00	0.8375E 01
40	0.4088E 02	0.4879E-00	0.4254E-00	0.8381E 01
41	0.4189E 02	0.4767E-00	0.4240E-00	0.8388E 01
42	0.4293E 02	0.4659E-00	0.4227E-00	0.8394E 01
43	0.4400E 02	0.4553E-00	0.4213E-00	0.8401E 01
44	0.4509E 02	0.4450E-00	0.4200E-00	0.8407E 01
45	0.4621E 02	0.4348E-00	0.4188E-00	0.8414E 01
46	0.4736E 02	0.4250E-00	0.4175E-00	0.8421E 01
47	0.4853E 02	0.4153E-00	0.4163E-00	0.8428E 01
48	0.4974E 02	0.4059E-00	0.4151E-00	0.8435E 01
49	0.5097E 02	0.3967E-00	0.4139E-00	0.8443E 01

OPTIMUM VENUS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 16.1

	R	FIR	VR	H
50	0.5224E 02	0.3877E-00	0.4128E-00	0.8450E 01
51	0.5353E 02	0.3789E-00	0.4116E-00	0.8458E 01
52	0.5486E 02	0.3704E-00	0.4105E-00	0.8466E 01
53	0.5622E 02	0.3620E-00	0.4094E-00	0.8474E 01
54	0.5762E 02	0.3538E-00	0.4084E-00	0.8482E 01
55	0.5905E 02	0.3457E-00	0.4074E-00	0.8490E 01
56	0.6052E 02	0.3379E-00	0.4064E-00	0.8499E 01
57	0.6202E 02	0.3302E-00	0.4054E-00	0.8508E 01
58	0.6356E 02	0.3227E-00	0.4044E-00	0.8517E 01
59	0.6513E 02	0.3154E-00	0.4035E-00	0.8526E 01
60	0.6675E 02	0.3082E-00	0.4025E-00	0.8535E 01
61	0.6841E 02	0.3012E-00	0.4016E-00	0.8544E 01
62	0.7011E 02	0.2944E-00	0.4008E-00	0.8554E 01
63	0.7185E 02	0.2877E-00	0.3999E-00	0.8564E 01
64	0.7363E 02	0.2811E-00	0.3990E-00	0.8574E 01
65	0.7546E 02	0.2747E-00	0.3982E-00	0.8585E 01
66	0.7733E 02	0.2685E-00	0.3974E-00	0.8595E 01
67	0.7925E 02	0.2623E-00	0.3966E-00	0.8606E 01
68	0.8122E 02	0.2563E-00	0.3959E-00	0.8617E 01
69	0.8323E 02	0.2505E-00	0.3951E-00	0.8629E 01
70	0.8530E 02	0.2448E-00	0.3944E-00	0.8640E 01
71	0.8742E 02	0.2392E-00	0.3936E-00	0.8652E 01
72	0.8959E 02	0.2337E-00	0.3929E-00	0.8665E 01
73	0.9181E 02	0.2283E-00	0.3923E-00	0.8677E 01
74	0.9409E 02	0.2231E-00	0.3916E-00	0.8690E 01
75	0.9643E 02	0.2180E-00	0.3909E-00	0.8703E 01
76	0.9882E 02	0.2130E-00	0.3903E-00	0.8716E 01
77	0.1013E 03	0.2081E-00	0.3896E-00	0.8730E 01
78	0.1038E 03	0.2033E-00	0.3890E-00	0.8744E 01
79	0.1064E 03	0.1986E-00	0.3884E-00	0.8758E 01
80	0.1090E 03	0.1940E-00	0.3878E-00	0.8773E 01
81	0.1117E 03	0.1896E-00	0.3873E-00	0.8788E 01
82	0.1145E 03	0.1852E-00	0.3867E-00	0.8804E 01
83	0.1173E 03	0.1809E-00	0.3862E-00	0.8819E 01
84	0.1202E 03	0.1767E-00	0.3856E-00	0.8836E 01
85	0.1232E 03	0.1726E-00	0.3851E-00	0.8852E 01
86	0.1263E 03	0.1686E-00	0.3846E-00	0.8869E 01
87	0.1294E 03	0.1647E-00	0.3841E-00	0.8886E 01
88	0.1326E 03	0.1609E-00	0.3836E-00	0.8904E 01
89	0.1359E 03	0.1572E-00	0.3831E-00	0.8922E 01
90	0.1393E 03	0.1535E-00	0.3827E-00	0.8941E 01
91	0.1428E 03	0.1500E-00	0.3822E-00	0.8960E 01
92	0.1463E 03	0.1465E-00	0.3818E-00	0.8980E 01
93	0.1499E 03	0.1431E-00	0.3813E-00	0.9000E 01
94	0.1536E 03	0.1397E-00	0.3809E-00	0.9020E 01
95	0.1575E 03	0.1365E-00	0.3805E-00	0.9041E 01
96	0.1614E 03	0.1333E-00	0.3801E-00	0.9063E 01
97	0.1654E 03	0.1302E-00	0.3797E-00	0.9085E 01
98	0.1695E 03	0.1271E-00	0.3793E-00	0.9107E 01
99	0.1737E 03	0.1242E-00	0.3789E-00	0.9130E 01
100	0.1780E 03	0.1213E-00	0.3786E-00	0.9154E 01

OPTIMUM VENUS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 16.1

CORRECTION RADII -- INNER ERRORS

	R	FIR	VR	H
2	0.1229E 02	0.1490E 01	0.5471E 00	0.6694E 01
3	0.1263E 02	0.1356E 01	0.5431E 00	0.6681E 01
4	0.1298E 02	0.1279E 01	0.5392E 00	0.6672E 01
5	0.1334E 02	0.1219E 01	0.5353E 00	0.6666E 01
6	0.1371E 02	0.1168E 01	0.5316E 00	0.6660E 01
7	0.1409E 02	0.1123E 01	0.5279E 00	0.6654E 01
8	0.1448E 02	0.1083E 01	0.5242E 00	0.6649E 01
9	0.1488E 02	0.1046E 01	0.5207E 00	0.6644E 01
10	0.1529E 02	0.1012E 01	0.5172E 00	0.6640E 01
11	0.1571E 02	0.9799E 00	0.5138E 00	0.6635E 01
12	0.1615E 02	0.9500E 00	0.5104E 00	0.6631E 01
13	0.1659E 02	0.9217E 00	0.5071E 00	0.6626E 01
14	0.1705E 02	0.8949E 00	0.5039E 00	0.6622E 01
15	0.1752E 02	0.8693E 00	0.5008E 00	0.6618E 01
16	0.1801E 02	0.8449E 00	0.4977E-00	0.6613E 01
17	0.1850E 02	0.8216E 00	0.4947E-00	0.6609E 01
18	0.1902E 02	0.7992E 00	0.4918E-00	0.6605E 01
19	0.1954E 02	0.7777E 00	0.4889E-00	0.6600E 01
20	0.2008E 02	0.7570E 00	0.4861E-00	0.6596E 01
21	0.2064E 02	0.7370E 00	0.4833E-00	0.6592E 01
22	0.2121E 02	0.7177E 00	0.4806E-00	0.6587E 01
23	0.2179E 02	0.6991E 00	0.4779E-00	0.6583E 01
24	0.2240E 02	0.6811E 00	0.4753E-00	0.6579E 01
25	0.2302E 02	0.6636E 00	0.4728E-00	0.6574E 01
26	0.2365E 02	0.6467E 00	0.4703E-00	0.6569E 01
27	0.2431E 02	0.6303E 00	0.4679E-00	0.6565E 01
28	0.2498E 02	0.6144E 00	0.4655E-00	0.6560E 01
29	0.2567E 02	0.5989E 00	0.4632E-00	0.6555E 01
30	0.2638E 02	0.5839E 00	0.4610E-00	0.6550E 01
31	0.2711E 02	0.5693E 00	0.4587E-00	0.6545E 01
32	0.2786E 02	0.5551E 00	0.4566E-00	0.6540E 01
33	0.2863E 02	0.5413E 00	0.4544E-00	0.6535E 01
34	0.2942E 02	0.5278E 00	0.4524E-00	0.6530E 01
35	0.3023E 02	0.5148E 00	0.4503E-00	0.6525E 01
36	0.3107E 02	0.5020E 00	0.4484E-00	0.6519E 01
37	0.3193E 02	0.4896E-00	0.4464E-00	0.6514E 01
38	0.3281E 02	0.4775E-00	0.4445E-00	0.6508E 01
39	0.3372E 02	0.4657E-00	0.4427E-00	0.6503E 01
40	0.3465E 02	0.4542E-00	0.4409E-00	0.6497E 01
41	0.3561E 02	0.4430E-00	0.4391E-00	0.6491E 01
42	0.3659E 02	0.4321E-00	0.4374E-00	0.6485E 01
43	0.3761E 02	0.4215E-00	0.4357E-00	0.6478E 01
44	0.3865E 02	0.4111E-00	0.4341E-00	0.6472E 01
45	0.3971E 02	0.4010E-00	0.4325E-00	0.6465E 01
46	0.4081E 02	0.3911E-00	0.4309E-00	0.6459E 01
47	0.4194E 02	0.3814E-00	0.4294E-00	0.6452E 01
48	0.4310E 02	0.3720E-00	0.4279E-00	0.6445E 01
49	0.4429E 02	0.3628E-00	0.4264E-00	0.6438E 01

OPTIMUM VENUS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 16.1

	R	FIR	VR	H
50	0.4552E 02	0.3539E-00	0.4250E-00	0.6430E 01
51	0.4678E 02	0.3451E-00	0.4236E-00	0.6423E 01
52	0.4807E 02	0.3366E-00	0.4222E-00	0.6415E 01
53	0.4940E 02	0.3283E-00	0.4209E-00	0.6407E 01
54	0.5076E 02	0.3202E-00	0.4196E-00	0.6399E 01
55	0.5217E 02	0.3122E-00	0.4183E-00	0.6391E 01
56	0.5361E 02	0.3045E-00	0.4171E-00	0.6383E 01
57	0.5509E 02	0.2969E-00	0.4159E-00	0.6374E 01
58	0.5661E 02	0.2895E-00	0.4147E-00	0.6365E 01
59	0.5818E 02	0.2823E-00	0.4136E-00	0.6356E 01
60	0.5979E 02	0.2753E-00	0.4124E-00	0.6347E 01
61	0.6144E 02	0.2684E-00	0.4114E-00	0.6337E 01
62	0.6314E 02	0.2617E-00	0.4103E-00	0.6327E 01
63	0.6489E 02	0.2552E-00	0.4092E-00	0.6317E 01
64	0.6668E 02	0.2488E-00	0.4082E-00	0.6307E 01
65	0.6852E 02	0.2426E-00	0.4072E-00	0.6296E 01
66	0.7042E 02	0.2365E-00	0.4063E-00	0.6285E 01
67	0.7237E 02	0.2306E-00	0.4053E-00	0.6274E 01
68	0.7437E 02	0.2248E-00	0.4044E-00	0.6263E 01
69	0.7642E 02	0.2191E-00	0.4035E-00	0.6251E 01
70	0.7854E 02	0.2136E-00	0.4027E-00	0.6239E 01
71	0.8071E 02	0.2082E-00	0.4018E-00	0.6227E 01
72	0.8294E 02	0.2030E-00	0.4010E-00	0.6214E 01
73	0.8523E 02	0.1978E-00	0.4002E-00	0.6201E 01
74	0.8759E 02	0.1928E-00	0.3994E-00	0.6188E 01
75	0.9001E 02	0.1879E-00	0.3986E-00	0.6174E 01
76	0.9250E 02	0.1832E-00	0.3978E-00	0.6160E 01
77	0.9506E 02	0.1785E-00	0.3971E-00	0.6145E 01
78	0.9769E 02	0.1740E-00	0.3964E-00	0.6131E 01
79	0.1004E 03	0.1696E-00	0.3957E-00	0.6115E 01
80	0.1032E 03	0.1652E-00	0.3950E-00	0.6100E 01
81	0.1060E 03	0.1610E-00	0.3944E-00	0.6084E 01
82	0.1089E 03	0.1569E-00	0.3937E-00	0.6067E 01
83	0.1120E 03	0.1529E-00	0.3931E-00	0.6050E 01
84	0.1151E 03	0.1490E-00	0.3925E-00	0.6033E 01
85	0.1182E 03	0.1452E-00	0.3919E-00	0.6015E 01
86	0.1215E 03	0.1415E-00	0.3913E-00	0.5997E 01
87	0.1249E 03	0.1378E-00	0.3907E-00	0.5978E 01
88	0.1283E 03	0.1343E-00	0.3902E-00	0.5958E 01
89	0.1319E 03	0.1308E-00	0.3897E-00	0.5939E 01
90	0.1355E 03	0.1275E-00	0.3891E-00	0.5918E 01
91	0.1393E 03	0.1242E-00	0.3886E-00	0.5897E 01
92	0.1431E 03	0.1210E-00	0.3881E-00	0.5876E 01
93	0.1471E 03	0.1179E-00	0.3876E-00	0.5853E 01
94	0.1511E 03	0.1148E-00	0.3872E-00	0.5831E 01
95	0.1553E 03	0.1118E-00	0.3867E-00	0.5807E 01
96	0.1596E 03	0.1090E-00	0.3863E-00	0.5783E 01
97	0.1640E 03	0.1061E-00	0.3858E-00	0.5759E 01
98	0.1686E 03	0.1034E-00	0.3854E-00	0.5734E 01
99	0.1732E 03	0.1007E-00	0.3850E-00	0.5708E 01
100	0.1780E 03	0.9808E-01	0.3846E-00	0.5681E 01

OPTIMUM VENUS H-TRAJECTORY FOR ORBITAL RANGE = 1.1 TO 16.1

POSSIBLE ORBITAL IMPULSES (DV/VCS)-- OUTER ERRORS

```
FO(  2)= 0.2570E-00     RO= 0.1610E 02
FO(  3)= 0.2570E-00     RO= 0.1616E 02
FO(  4)= 0.2570E-00     RO= 0.1619E 02
FO(  5)= 0.2571E-00     RO= 0.1621E 02
FO(  6)= 0.2571E-00     RO= 0.1623E 02
FO(  7)= 0.2571E-00     RO= 0.1625E 02
FO(  8)= 0.2571E-00     RO= 0.1626E 02
FO(  9)= 0.2571E-00     RO= 0.1628E 02
FO( 10)= 0.2571E-00     RO= 0.1629E 02
FO( 11)= 0.2571E-00     RO= 0.1630E 02
FO( 12)= 0.2571E-00     RO= 0.1632E 02
FO( 13)= 0.2571E-00     RO= 0.1633E 02
FO( 14)= 0.2571E-00     RO= 0.1634E 02
FO( 15)= 0.2571E-00     RO= 0.1636E 02
FO( 16)= 0.2571E-00     RO= 0.1637E 02
FO( 17)= 0.2571E-00     RO= 0.1638E 02
FO( 18)= 0.2571E-00     RO= 0.1639E 02
FO( 19)= 0.2571E-00     RO= 0.1641E 02
FO( 20)= 0.2571E-00     RO= 0.1642E 02
FO( 21)= 0.2571E-00     RO= 0.1643E 02
FO( 22)= 0.2571E-00     RO= 0.1644E 02
FO( 23)= 0.2571E-00     RO= 0.1646E 02
FO( 24)= 0.2571E-00     RO= 0.1647E 02
FO( 25)= 0.2571E-00     RO= 0.1648E 02
FO( 26)= 0.2571E-00     RO= 0.1650E 02
FO( 27)= 0.2571E-00     RO= 0.1651E 02
FO( 28)= 0.2571E-00     RO= 0.1652E 02
FO( 29)= 0.2571E-00     RO= 0.1654E 02
FO( 30)= 0.2571E-00     RO= 0.1655E 02
FO( 31)= 0.2571E-00     RO= 0.1657E 02
FO( 32)= 0.2571E-00     RO= 0.1658E 02
FO( 33)= 0.2571E-00     RO= 0.1659E 02
FO( 34)= 0.2571E-00     RO= 0.1661E 02
FO( 35)= 0.2571E-00     RO= 0.1662E 02
FO( 36)= 0.2571E-00     RO= 0.1664E 02
FO( 37)= 0.2571E-00     RO= 0.1665E 02
FO( 38)= 0.2571E-00     RO= 0.1667E 02
FO( 39)= 0.2571E-00     RO= 0.1669E 02
FO( 40)= 0.2571E-00     RO= 0.1670E 02
FO( 41)= 0.2571E-00     RO= 0.1672E 02
FO( 42)= 0.2571E-00     RO= 0.1674E 02
FO( 43)= 0.2571E-00     RO= 0.1675E 02
FO( 44)= 0.2571E-00     RO= 0.1677E 02
FO( 45)= 0.2571E-00     RO= 0.1679E 02
FO( 46)= 0.2571E-00     RO= 0.1681E 02
FO( 47)= 0.2572E-00     RO= 0.1682E 02
FO( 48)= 0.2572E-00     RO= 0.1684E 02
FO( 49)= 0.2572E-00     RO= 0.1686E 02
```

OPTIMUM VENUS H-TRAJECTORY FOR ORBITAL RANGE =1.1 TO 16.1

FO(50)= 0.2572E-00	RO= 0.1688E 02
FO(51)= 0.2572E-00	RO= 0.1690E 02
FO(52)= 0.2572E-00	RO= 0.1692E 02
FO(53)= 0.2572E-00	RO= 0.1694E 02
FO(54)= 0.2572E-00	RO= 0.1697E 02
FO(55)= 0.2572E-00	RO= 0.1699E 02
FO(56)= 0.2572E-00	RO= 0.1701E 02
FO(57)= 0.2572E-00	RO= 0.1703E 02
FO(58)= 0.2572E-00	RO= 0.1706E 02
FO(59)= 0.2572E-00	RO= 0.1708E 02
FO(60)= 0.2572E-00	RO= 0.1710E 02
FO(61)= 0.2572E-00	RO= 0.1713E 02
FO(62)= 0.2572E-00	RO= 0.1715E 02
FO(63)= 0.2572E-00	RO= 0.1718E 02
FO(64)= 0.2572E-00	RO= 0.1721E 02
FO(65)= 0.2572E-00	RO= 0.1723E 02
FO(66)= 0.2572E-00	RO= 0.1726E 02
FO(67)= 0.2573E-00	RO= 0.1729E 02
FO(68)= 0.2573E-00	RO= 0.1732E 02
FO(69)= 0.2573E-00	RO= 0.1735E 02
FO(70)= 0.2573E-00	RO= 0.1738E 02
FO(71)= 0.2573E-00	RO= 0.1741E 02
FO(72)= 0.2573E-00	RO= 0.1744E 02
FO(73)= 0.2573E-00	RO= 0.1748E 02
FO(74)= 0.2573E-00	RO= 0.1751E 02
FO(75)= 0.2573E-00	RO= 0.1754E 02
FO(76)= 0.2573E-00	RO= 0.1758E 02

OPTIMUM VENUS H-TRAJECTORY FOR ORBITAL RANGE =1.1 TO 16.1

POSSIBLE ORBITAL IMPULSES (DV/VCS)-- INNER ERRORS

```
FO(  2)= 0.2620E-00      RO= 0.1221E 02
FO(  3)= 0.2620E-00      RO= 0.1218E 02
FO(  4)= 0.2620E-00      RO= 0.1216E 02
FO(  5)= 0.2620E-00      RO= 0.1214E 02
FO(  6)= 0.2620E-00      RO= 0.1213E 02
FO(  7)= 0.2620E-00      RO= 0.1211E 02
FO(  8)= 0.2620E-00      RO= 0.1210E 02
FO(  9)= 0.2620E-00      RO= 0.1209E 02
FO( 10)= 0.2620E-00      RO= 0.1208E 02
FO( 11)= 0.2620E-00      RO= 0.1207E 02
FO( 12)= 0.2620E-00      RO= 0.1205E 02
FO( 13)= 0.2621E-00      RO= 0.1204E 02
FO( 14)= 0.2621E-00      RO= 0.1203E 02
FO( 15)= 0.2621E-00      RO= 0.1202E 02
FO( 16)= 0.2621E-00      RO= 0.1201E 02
FO( 17)= 0.2621E-00      RO= 0.1200E 02
FO( 18)= 0.2621E-00      RO= 0.1199E 02
FO( 19)= 0.2621E-00      RO= 0.1198E 02
FO( 20)= 0.2621E-00      RO= 0.1197E 02
FO( 21)= 0.2621E-00      RO= 0.1196E 02
FO( 22)= 0.2621E-00      RO= 0.1195E 02
FO( 23)= 0.2621E-00      RO= 0.1193E 02
FO( 24)= 0.2621E-00      RO= 0.1192E 02
FO( 25)= 0.2621E-00      RO= 0.1191E 02
FO( 26)= 0.2621E-00      RO= 0.1190E 02
FO( 27)= 0.2621E-00      RO= 0.1189E 02
FO( 28)= 0.2622E-00      RO= 0.1188E 02
FO( 29)= 0.2622E-00      RO= 0.1187E 02
FO( 30)= 0.2622E-00      RO= 0.1185E 02
FO( 31)= 0.2622E-00      RO= 0.1184E 02
FO( 32)= 0.2622E-00      RO= 0.1183E 02
FO( 33)= 0.2622E-00      RO= 0.1182E 02
FO( 34)= 0.2622E-00      RO= 0.1180E 02
FO( 35)= 0.2622E-00      RO= 0.1179E 02
FO( 36)= 0.2622E-00      RO= 0.1178E 02
FO( 37)= 0.2622E-00      RO= 0.1176E 02
FO( 38)= 0.2622E-00      RO= 0.1175E 02
FO( 39)= 0.2622E-00      RO= 0.1173E 02
FO( 40)= 0.2623E-00      RO= 0.1172E 02
FO( 41)= 0.2623E-00      RO= 0.1170E 02
FO( 42)= 0.2623E-00      RO= 0.1169E 02
FO( 43)= 0.2623E-00      RO= 0.1167E 02
FO( 44)= 0.2623E-00      RO= 0.1166E 02
FO( 45)= 0.2623E-00      RO= 0.1164E 02
FO( 46)= 0.2623E-00      RO= 0.1162E 02
FO( 47)= 0.2623E-00      RO= 0.1161E 02
FO( 48)= 0.2623E-00      RO= 0.1159E 02
FO( 49)= 0.2624E-00      RO= 0.1157E 02
```

OPTIMUM VENUS H-TRAJECTORY FOR ORBITAL RANGE =1.1 TO 16.1

FO(50)= 0.2624E-00	RO= 0.1155E 02
FO(51)= 0.2624E-00	RO= 0.1154E 02
FO(52)= 0.2624E-00	RO= 0.1152E 02
FO(53)= 0.2624E-00	RO= 0.1150E 02
FO(54)= 0.2624E-00	RO= 0.1148E 02
FO(55)= 0.2624E-00	RO= 0.1146E 02
FO(56)= 0.2625E-00	RO= 0.1143E 02
FO(57)= 0.2625E-00	RO= 0.1141E 02
FO(58)= 0.2625E-00	RO= 0.1139E 02
FO(59)= 0.2625E-00	RO= 0.1137E 02
FO(60)= 0.2625E-00	RO= 0.1135E 02
FO(61)= 0.2625E-00	RO= 0.1132E 02
FO(62)= 0.2626E-00	RO= 0.1130E 02
FO(63)= 0.2626E-00	RO= 0.1127E 02
FO(64)= 0.2626E-00	RO= 0.1125E 02
FO(65)= 0.2626E-00	RO= 0.1122E 02
FO(66)= 0.2627E-00	RO= 0.1119E 02
FO(67)= 0.2627E-00	RO= 0.1117E 02
FO(68)= 0.2627E-00	RO= 0.1114E 02
FO(69)= 0.2627E-00	RO= 0.1111E 02
FO(70)= 0.2628E-00	RO= 0.1108E 02
FO(71)= 0.2628E-00	RO= 0.1105E 02
FO(72)= 0.2628E-00	RO= 0.1102E 02
FO(73)= 0.2628E-00	RO= 0.1098E 02
FO(74)= 0.2629E-00	RO= 0.1095E 02
FO(75)= 0.2629E-00	RO= 0.1092E 02
FO(76)= 0.2629E-00	RO= 0.1088E 02
FO(77)= 0.2630E-00	RO= 0.1085E 02
FO(78)= 0.2630E-00	RO= 0.1081E 02
FO(79)= 0.2631E-00	RO= 0.1077E 02
FO(80)= 0.2631E-00	RO= 0.1073E 02
FO(81)= 0.2631E-00	RO= 0.1069E 02
FO(82)= 0.2632E-00	RO= 0.1065E 02
FO(83)= 0.2632E-00	RO= 0.1061E 02
FO(84)= 0.2633E-00	RO= 0.1057E 02
FO(85)= 0.2633E-00	RO= 0.1052E 02
FO(86)= 0.2634E-00	RO= 0.1048E 02
FO(87)= 0.2634E-00	RO= 0.1043E 02
FO(88)= 0.2635E-00	RO= 0.1038E 02
FO(89)= 0.2636E-00	RO= 0.1033E 02
FO(90)= 0.2636E-00	RO= 0.1028E 02
FO(91)= 0.2637E-00	RO= 0.1023E 02
FO(92)= 0.2638E-00	RO= 0.1018E 02
FO(93)= 0.2638E-00	RO= 0.1013E 02
FO(94)= 0.2639E-00	RO= 0.1007E 02
FO(95)= 0.2640E-00	RO= 0.1001E 02
FO(96)= 0.2641E-00	RO= 0.9954E 01
FO(97)= 0.2642E-00	RO= 0.9894E 01
FO(98)= 0.2642E-00	RO= 0.9832E 01
FO(99)= 0.2643E-00	RO= 0.9768E 01
FO(100)= 0.2644E-00	RO= 0.9703E 01

Program 9

```
3FUNK   LINEAR PERTURBATICN THEORY--FCR THEOR. OPT. REF. TRAJ.

2000 READ INPUT TAPE 2,2001,RIN,VIN,I
2001 FCRMAT(2(E10.0),I3)
3000 WRITE CUTPUT TAPE 3,3001,RIN,VIN
3001 FCRMAT(10X,47HLINEAR PERTURBATION THECRY--THEOR.OPT.REF.TRAJ.//
30011    10X,4HRIN=,E11.4,3X,4HVIN=,E11.4//
30012    19X,4HR/RS, 7X,11HTHETA V (D),5X,11HTHETA R (D)  )
1     RTD=57.29578
2     ROOT2=1.414214
3     VINSC=VIN**2
4     RC=2.0/VINSC
5     X=I-1
6     EX=1.0/X
7     RM=(RIN/RC)**EX
8     R=RC
81    FACT=(2.0*VIN - ROOT2) / (VIN+ROOT2)
82    ZA=VINSQ-2.0/RIN
9     DO 20 J=1,I
C  MAX.VEL.PERT
901   VRSQ= ZA+2.0/R
902   VR=SQRTF(VRSQ)
10    CSCSQ=R**2*VRSQ*ZA/8.0
11    COTSQ=CSCSQ-1.0
12    COT=SQRTF(COTSQ)
13    VSQRAT= VRSQ/ZA
14    DIV1=VSQRAT*FACT + 1.0
15    CV=ATANF(COT/DIV1)
C  MAX.ORB.RAD.PERT
16    DIV2=1.0-VSQRAT/2.0
17    CR=ATANF(COT/DIV2)
18    CVD=CV*RTD
19    CRD=CR*RTD
3002 WRITE OUTPUT TAPE3,3003,J,R,CVD,CRD
3003 FORMAT(10X,I3,2X,3(E11.4,5X))
20    R=R*RM
      CALL EXIT
      END(1,0,0,0,0,0,1,0,0,1,0,0,0,0,0)
```

Program 10

```
4FUNK   LINEAR PERTURBATION THEORY--AT SPHERE OF INFLUENCE

2000 READ INPUT TAPE 2,2001,I,RIN,VIN,FII,DFI,G,RS
2001 FORMAT(I5,6E10.0)
3000 WRITE OUTPUT TAPE 3,3001,RIN,VIN,G,RS
3001 FORMAT(10X,50HLINEAR PERTURBATION THEORY--AT SPHERE OF INFLUENCE//
30011    10X,4HRIN=,E11.4,3X,4HVIN=,E11.4,3X,2HG=,E11.4,3X,3HRS=,E11.4//
30012    19X,5HFI(D),7X,11HTHETA V (D),5X,11HTHETA R (D)  )
1     RTD=57.29578
101   DTR=.017453293
201   VE=29.8
202   VCSESQ=395.0/6.37
203   VCS=SQRTF(VCSESQ*G/RS)
204   VIN=VIN*VE
205   VIN=VIN/VCS
3     VINSQ=VIN**2
4     DFI=DFI*DTR
5     FII=FII*DTR
6     FI=FII
7     ZA=VINSQ-2.0/RIN
C  MAX.VEL.PERT
8     DO 20 J=1,I
801   SFI=SINF(FI)
9     H=SFI*RIN*VIN
10    CSCSQ=1.0/SFI**2
11    COTSQ=CSCSQ-1.0
12    COT=SQRTF(COTSQ)
13    EC=SQRTF(H**2*ZA+1.0)
14    VOSQ=ZA*(EC+1.0)/(EC-1.0)
15    VO=SQRTF(VOSQ)
16    VSQRAT=VINSQ/VOSQ
17    DIV1=VSQRAT*(H-1.0)/(1.0-1.0/VO) + 1.0
1701 OV=ATANF(COT/DIV1)
C  MAX.ORB.RAD.PERT
1702 DIV2=1.0-VSQRAT
1703 OR=ATANF(COT/DIV2)
18    OVD=OV*RTD
19    ORD=OR*RTD
191   FID =FI *RTD
192   IF(OVD) 193,3002,3002
193   OVD=180.0+OVD
3002 WRITE OUTPUT TAPE3,3003,J,FID ,OVD,ORD
3003 FORMAT(10X,I3,2X,3(E11.4,5X))
20    FI=FI+DFI
      CALL EXIT
      END(1,0,0,0,0,0,1,0,0,1,0,0,0,0,0)
```